Energy, Mines and
Resources Canada

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Ressources Canada

OVERVIEW STUDY OF THE POTENTIAL FOR YUKON COMMUNITIES TO REDUCE THEIR DEPENDENCE ON OIL

YUKON REMOTE COMMUNITY
ENERGY OVERVIEW STUDY

Prepared for:
ENERGY, MINES AND RESOURCES CANADA
REMOTE COMMUNITY DEMONSTRATION PROGRAM

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P6929.00
January, 1984

ACKNOWLEDGEMENTS

The Acres - Arctech project team would like to thank all of the Yukon companies, and Federal, Territorial, and Municipal government departments who assisted by providing energy records and specific information during the data collection. Without their cooperation, this project would not have been possible.

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1.0 EXECUTIVE SUMMARY

1.0 EXECUTIVE SUMMARY

The general purpose of this desk study overview is to ascertain the potential for Yukon communities to reduce their dependence on oil. Specific objectives are to:

- outline the Yukon energy environment, including barriers to oil displacement;
- document current energy consumption patterns for individual communities;
- provide brief community profiles from an energy perspective;
- consider community off oil options based on practical technology;
- recommend measures for reducing oil consumption;
- identify gaps in the energy picture requiring further study.

As shown in Table 1-1 all communities in the Yukon are highly dependent on refined petroleum products for space heating requirements. Half of them also rely on diesel fuel for electrical generation needs. As a result, close to 75 million liters of fuel oil were consumed in the Yukon in 1982 for these purposes.

Residential space heating represents the most significant end-use for oil. There is evidence of an increasing trend toward using wood as either a supplement or substitute to oil heating. The potential for further wood use is significant. Wood burning has made only minor penetration into the government, commercial and industrial sectors however.

While the oil consumed for electrical generation in the Yukon is less than 10 percent of that used for space heating, it presents a particularly difficult problem in that the conversion inefficiencies inherent in diesel generation make the resulting energy quite expensive.

About one-quarter of the total energy demand of Yukon communities is supplied by hydro-electric generation. Eight communities, including Whitehorse, the largest, are supplied electricity from an interconnected grid stretching from Haines Junction in the southwest to Ross River in the northeast. An isolated hydro-electric distribution system also serves the communities of Mayo, Elsa and Keno.

Invariably, the most cost-effective and practical means of reducing oil consumption in remote communities in the Yukon is through conservation. Based on limited data on air-

TABLE 1-1

YUKON COMMUNITIES ENERGY USE SUMMARY

COMMUNITY	POPN	GJ INPUT PERCAPITA	GJ USED PERCAPITA	TOTAL MWH	TOTAL SPHT GJ	WOOD GJ	OIL GJ	ELEC FUEL GJ
STEWART CROSSING	20	467	235	380	3360	0	3360	6000
JOHNSONS CROSSING	10	353	185	33	1730	1430	300	1800
BEAVER CREEK	90	339	234	1000	17500	800	16700	13000
DAWSON CITY	900	266	191	7000	147000	16700	130300	92000
SWIFT RIVER	35	264	154	240	4500		4500	4700
DESTRUCTION BAY	80	247	167	700	10800	1600	9200	9000
WATSON LAKE	1140	209	144	8900	132600	21000	111600	105600
BURWASH LANDING	70	190	140	400	8800	4800	4000	5100
UPPER LIARD	130	157	138	300	17000	15100	1900	3600
TESLIN	368	155	112	1770	35000	15100	19900	22000
ROSS RIVER	325	137	137	1450	39400	21000	18400	
WHITEHORSE	15000	135	135	140000	1527000	91000	1436000	
HAINES JUNCTON	460	134	134	3200	50000	13600	36400	
OLD CROW	240	127	96	700	20800	14700	6100	10000
MAYO	500	127	127	4000	49300	9200	40100	
CARMACKS	340	122	122	1900	34400	15200	19200	
PELLY CROSSING	180	120	77	680	11600	7200	4400	10300
CARCROSS	270	111	111	1000	26300	13900	12400	
KENO	90	105	105	200	8500	4250	4250	
FARO	1700	102	102	14800	120000		120000	
ELSA	400	93	93	2900	26900		26900	
TAGISH- MARSH LK	480	74	74	600	33500	25500	8000	
TOTAL	22828			192153	2325990	292080	2033910	283100
AVERAGE		183	137					
INDUSTRIAL FARO				125000	coal:	150000	22000	
INDUSTRIAL ELSA				26500			113000	
TOTAL YUKON	22828			343653	2325990		2168910	283100
						TOTAL OIL:	2452010	
						TOTAL FUEL	2894090	

tightness and insulation levels in the Yukon, it is certain that most buildings could effect direct reductions in oil consumption for space heating by retrofitting additional insulation and air-vapour barriers. Commercial and government buildings, which tend to be heated solely by oil, represent the best opportunities for oil savings.

For communities dependent upon diesel electric generation, waste heat recovery offers another proven and effective means for conservation. It is probably not feasible to provide extensive hot water distribution systems in most communities, but large buildings or closely clustered sets of buildings could certainly benefit.

Hydro and wood are the most plentiful renewable energy resources in the Yukon. Both are used now and consumption could be increased to displace more oil. Many communities in the Yukon have good access to large areas of fire-killed forest which serve as excellent sources of dry, seasoned firewood. Wood is readily applicable for space heating purposes while electrical generation fueled by wood is more problematical. (Wood is obviously less convenient than oil, but increasing oil prices are overcoming this objection.) Many communities would benefit from the development of a fully integrated wood supply system to remove some of the barriers inherent in its use. Supply and handling difficulties are also critical when considering large scale applications of wood as an energy source.

The combination of good supply and sufficiently large load demand could indicate the suitability of using wood for electric generation in communities such as Watson Lake or Teslin. At the present time, however, conventional steam powered generation is the only proven technology, and this requires very large quantities of wood. Detailed investigation of the economics of such a system would be required before a demonstration project could be initiated. Almost certainly, heat recovery and district heating would have to be incorporated in the system.

Small hydro offers an opportunity to virtually eliminate all oil consumption in remote communities for other than transportation uses. Several communities, that are presently served by diesel electricity, are identified in this study as having sites nearby where hydro could be developed. Although hydro offers very low operating costs, the capital costs can be quite high. In addition, the social and environmental constraints to specific potential hydro sites can be significant. Detailed site investigations are required to determine these factors. Nevertheless, using some "rule of thumb" estimates, several opportunities for small hydro appear promising.

Grid connected communities could also reduce their oil dependence to very minor levels by converting from oil heating to electric heating. Already, the price differential between the two is diminishing and future oil increases will clearly tip the balance in favour of electricity. The key question becomes one of capacity on the system. At the present time, there is a surplus of close to 20 MW, enough to satisfy the total energy needs of between one-third and one-half of the households in the Yukon. However, this surplus largely results from the shut down of the lead-zinc mining works at Faro. Whether Cyprus Anvil will require this capacity in the future creates a serious policy dilemma for the time being.

Other technologies which show some promise in at least one community in the Yukon include:

- Biogas Production from Organic Waste;
- Wind Power/Pumped Storage;
- Heat Pumps;
- Propane.

2.0 BACKGROUND

2.0 BACKGROUND

2.1 INTRODUCTION

Based on 1980/81 normal levels of economic activity and the energy consumption patterns in the Yukon identified in this report (see Section 3.0), it is estimated that Yukon communities will require over 1.8 billion litres of oil (400 million gallons) over the next 20 years. The estimated cost of this form of energy, including capital, operating and maintenance, could be over $1 billion in 1983 dollars. The offshore value of the oil alone is in the region of $38 million per annum or $750 million over 20 years in 1983 dollars.

Energy is a key component in the development of northern communities, and an improved standard of living for local populations is heavily dependent upon energy availability at acceptable cost. However, oil products cost from 25 to 200 percent more than in Southern communities and diesel generated electricity costs five to twenty times more than electricity supplied via major provincial grid systems. Thus, a wide variety of incentives to seek out opportunities to reduce dependency on oil could be expected.

Unfortunately, a host of economic, technical and institutional barriers presently mitigate against a rapid deployment of viable energy supply alternatives through existing institutions. Impediments range from inadequate analysis of suitable development opportunities, through inappropriate institutional responsibilities and mandates, to a shortage of the necessary capital and operating funding. The seasonal nature of several alternative energy sources such as hydro, solar and wind, as well as variation in the load and limited means for energy storage add to the difficulties. Moreover, the nature of the expected loads, conditions, geology, topography and similar local factors, vary greatly from location to location. Thus, an energy system suitable for one community may not be suitable for another.

2.2 REMOTE COMMUNITY DEMONSTRATION PROGRAM

With an understanding of this background, the Federal Government announced a Remote Communities Initiative in the fall of 1980, as part of its National Energy Program (NEP), the thrust of which is a broad set of initiatives directed towards substitution of oil consumption with renewable resources and to respond to the special energy problems of remote communities. To encourage development of the economies and opportunities of northern communities, in the face of rising fuel costs and potential shortages, specific efforts must be made to analyse current energy usage. This applies particularly to the largest energy demand components, namely high cost oil products for space heating and diesel generated electricity.

This policy challenge is heightened by the diversity and uniqueness of many of the communities in view of their geographic location, social fabric and organization (e.g. urban, mining, service, native, etc.) as well as the technical and economic difficulties noted in section 2.1.

In recognition of these problems and uncertainties, as well as the federal government's role in energy technology research, development and demonstration, a four year program known as the Remote Community Demonstration Program (RCDP) has been developed by ENERGY, MINES AND RESOURCES, CANADA.

The overall objective of this program is to promote an awareness in remote communities of off-oil opportunities consisting of energy use management, energy reduction measures and viable energy supply alternatives.

The RCDP program has recently been extended to March 31, 1989 and has received an authorized funding level of $16 million. Some 40% of these funds have been dedicated to the Yukon and the Northwest Territories.

The Program has been divided into two complementary phases.

Phase I has provided funds during fiscal years 1982/83 and 1983/84 for studies to develop a data base on energy supply, management and use, in the nearly four hundred remote communities in Canada. These studies are also designed to assess and perform a preliminary screening of practical off-oil options available to remote communities in the context of specific energy tehcnologies, conservation measures, and supply options. They are further intended to identify projects which may be considered for implementation under Phase Two of the Program, or separately under other federal and provincial programs, and private and public sector initiatives.

Phase II of RCDP will provide funds in support of demonstrations of specific alternate energy supply or energy conservation projects and measures. Such projects will provide for the demonstration of both mature technologies and techniques, as well as promising new technologies which appear to have particular relevance to remote communities. The purpose of the demonstration projects under this phase of the Program is to make remote communities with common energy supply and energy demand management (conservation) options aware of feasible techniques, technologies, and measures, as well as the means of putting them into place.

To be eligible for the program, communities must be permanent and have no less than ten occupied dwellings and not be connected to interprovincial gas or electric grids. All communities in the Yukon and Northwest Territories are eligible. Due to the isolation and severe climatic conditions of the locations under consideration, any proposed alternative energy services must place emphasis on reliability, ruggedness and simplicity of operation. Moreover, since many of the communities are not large, and rapid near-term expansion unlikely, development of such services in modular units, to match demand growth, is desirable. In this way, initial capital outlay can be contained, yet permitting an evaluation of trial systems under actual working conditions, with due regard to cost effectiveness.

2.3 STUDY OBJECTIVES

The purpose of this effort in Phase I is to conduct a desk study overview of the energy supply and consumption situation at the community, territorial and national levels for communities in the Yukon. A total of twenty-six Yukon communities were identified in the study terms of reference, four of which were subsequently deleted for the following reasons:

- Champagne and Klukshu: less than 10 permanent dwellings;
- Eagle River: lodge location only; and
- MacMillan Pass: mining exploration camps only.

Of the remaining twenty-two, eight are connected to hydroelectric supply grids. The twenty-two comunities are shown on the locational map in Figure 2-1.

The information assembled in this study will be used by ENERGY, MINES AND RESOURCES for program design purposes. In particular, it will be used to develop selection criteria for the Phase II demonstration projects, as well as provide useful background information for their subsequent evaluation. The study will also be the subject of information transfer to remote communities under RCDP.

Included in this study are:

- an outline of the Yukon energy environment. This includes energy supply and demand and barriers to oil displacement.

- an overview of community off-oil options based on practical technology for both conservation opportunities and resource alternatives.

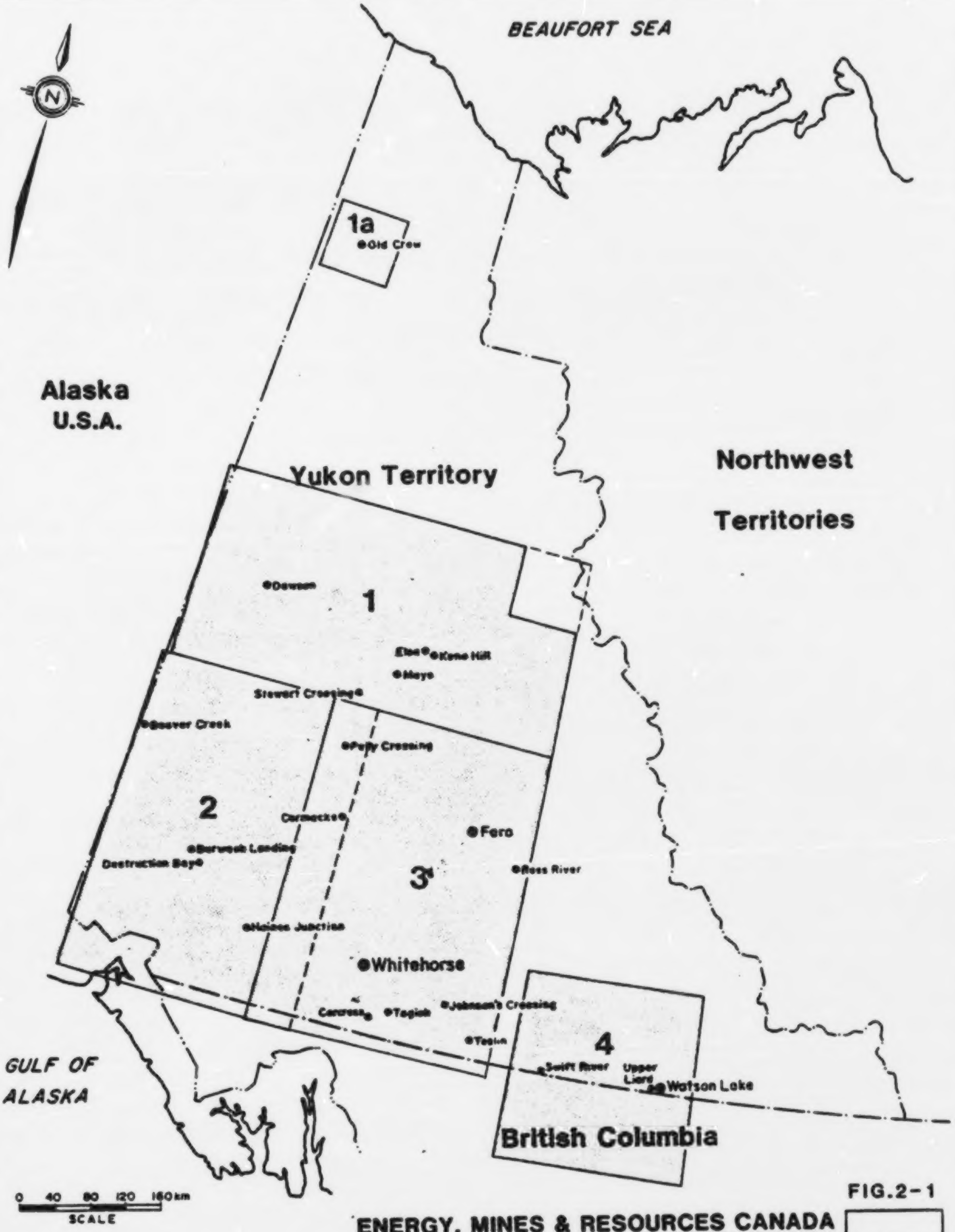
BEAUFORT SEA
N
1a
Old Crow
Alaska
U.S.A.
Yukon Territory
Northwest
Territories
Dawson
1
Elsa
Keno Hill
Mayo
Stewart Crossing
Beaver Creek
Pelly Crossing
2
Carmacks
Faro
Burwash Landing
Destruction Bay
Ross River
3
Haines Junction
Whitehorse
Carcross
Tagish
Johnson's Crossing
Teslin
4
Swift River
Upper Liard
Watson Lake
GULF OF
ALASKA
British Columbia
0 40 80 120 160 km
SCALE

FIG.2-1

ENERGY, MINES & RESOURCES CANADA
YUKON OFF-OIL STUDY

LOCATION MAP

NOTE: For detailed plans of Areas I through 4 see Energy Resource Alternatives maps, Appendix A.

- brief community profiles from an energy perspective. These include depictions of physical, cultural and economic settings along with community facilities.
- recommendations for preferred off-oil options bearing in mind resource availability, operational factors, infrastructure requirements, economic feasibility and growth or decline of the community.
- information gaps in the energy picture or areas requiring further study and follow up.
- energy bibliography of off-oil references applicable to the identified Yukon communities.

A considerable amount of information and data has already been acquired directly by the Yukon Territorial Government, community representatives and the Yukon CREO/EMR for various purposes. A community profile is being prepared for publication by the Government of Yukon. A broad range of data is available for collection on limited aspects of energy supply, distribution, use and cost. However, this data base lacks focus and completeness for specific application.

In order to handle this significant amount of information at a desk study overview level, and to avoid tedious repetition, it is convenient for energy purposes to categorize the Yukon communities into three basic groups. These are:

- urban communities
- mining communities
- other communities

This report has been structured accordingly. In dealing with alternative energy resources, however, the scale of development, technical design, scheduling costs and other factors, which must be considered, must be modified to suit local requirements, even for the same technology. Thus, the most appropriate type of system and its specific characteristics can only be determined upon a detailed examination of individual community requirements, and the technical resources and site conditions at the proposed location. Such detailed examinations are beyond the scope of this study.

2.4 PROJECT TASK ORGANIZATION

This study represents a cooperative effort of Acres Consulting Services Limited and Arctech Community Energy Research Associates. The responsibility for various tasks required for the preparation of this report were divided between the two companies based upon previous experience in energy conservation and alternative energy applications.

Arctech had primary responsibility for the collection and tabulation of all field data and the preparation of the Energy Profiles for each community. These were used by Arctech to develop the discussions of energy conservation opportunities and the energy planning measures for each community. Arctech also developed the section on biogas generation in conjunction with Neils Jacobsen, civil engineering consultant, Whitehorse.

Acres had primary responsibility for preparing the discussions of Yukon energy supply and demand, the evaluations of oil-reduction technologies and the community specific energy supply alternatives. Utilizing the data and critical comments provided by Arctech, Acres coordinated the report preparation, map production, document assembly and publication.

3.0 YUKON ENERGY ENVIRONMENT

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3.1 ENERGY DEMAND

In order to assess the appropriateness of oil reduction measures for remote communities, it is necessary to understand current consumption patterns. Typically, any statistical compilation of demand reveals a wide range of total demand as well as a great deal of variability in fuel type selection. The total of all fuel inputs and end uses could not be determined for any of the 22 communities with the energy data available for this study. Without the benefit of site visits and building inspections, details of energy consumption are not apparent. However, with the sampling of available data, a reasonable estimate of community energy use can be derived.

A number of sources for energy consumption data were found in the course of this study. Key samplings of consumption data available for this exercise were:

Government Consumption

- Fuel use records for YTG Buildings
- RCMP fuel and electricity purchase records
- Federal government real property inventory
- NCPC and YECL electric sales records
- Federal and Territorial Government fuel requirement estimates for 1983-84
- Territorial government building inventory.

Residential Consumption

- Statistics Canada housing data
- NCPC and YECL electric sales records
- Yukon Housing Corporation fuel and electricity purchase records
- Pioneer Grant Houses Survey Program - CREDA Project
- Cyprus Anvil Mining Corporation - Faro housing data
- 1982-83 EMR Residential Survey Program data
- YTG tax records
- Government of Canada fuel rebate program data
- Native Band representatives

Commercial Consumption

- NCPC and YECL electric sales records
- YTG Energy Branch Commercial Building Surveys
- Government of Canada Electricity Rebate Program

Industrial Consumption

- NCPC and YECL electric sales records
- Mining company data

In general, the available data was found to be quite reliable for electric consumption while oil and wood use data was generally estimated on the basis of survey models or building owner/operator interviews. The commercial sector proved the most difficult to analyze since no body of data exists which links actual consumption with any inventory of buildings or uses. None provides a complete picture of Yukon demand but with the use of some judgement and extrapolation, total demand can be estimated.

3.1.1 Energy Use by Sectors

In terms of energy consumption the residential sector is by far the most predominant in most Yukon Communities.

Faro, Elsa, Keno and Mayo are exceptions due to the large industrial loads associated with the mining operations located near these communities. Also, in Whitehorse, the commercial sector is quite significant. Excluding the industrial load for the mines, the bulk of the energy requirements in all other sectors arise from space heating demands.

Table 3.1 indicates the estimated energy use by sector in the Yukon. For electrical consumption, the industrial sector is the largest by a wide margin. This is based on 1981/82 consumption levels when the major mines in the Yukon were in operation. Of the 545 TJ indicated for the industrial sector, Cyprus Anvil alone accounts for approximately 80%.

The residential sector is the next largest consuming group at 370 TJ of electrical energy or 30% of the total consumed in the Yukon. This represents approximately 13,500 kW hours of energy per annum per household. The commercial sector, with 222 TJ, is the next largest group followed by government which consumes about 100 TJ. Schools are the greatest single electrical users in the government sector, consuming about 2% of the total Yukon electric generation.

The residential sector is predominant in the thermal energy column, accounting for 39 percent of the total thermal consumption. The 1,140 TJ indicated for the residential sector amounts to about 150 GJ per household on average. This is the equivalent of over 3,900 litres of oil per annum per household.

Although the thermal requirements for the total industrial sector were not available for this study, estimates were obtained from Cyprus Anvil and United Keno Hill Mines which represent the bulk of the demand. These two operations account for 172 TJ and 113 TJ respectively. The remainder of the industrial demand is included in the commercial sector.

TABLE 3-1

ENERGY USE BY SECTOR

Sector	Electrical Energy(1)		Thermal Energy		Total Energy	
	TJ	%	TJ	%	TJ	%
Residential	370	30	1140(2)	39	1510	36
Industrial	545	44	285	10	830	20
Commercial	222	18	885(3)	30	1107	27
Education	23	2	120(4)	4	143	4
Other Government	76	6	465(4)	17	541	13
	1237	100	2895	100	4131	100

Notes:

1. Based on sales summaries provided by NCPC and YECL.
2. Based on average of 150 GJ per household.
3. Derived from electric GJ/fuel GJ ratio of .35.
4. YTG Records.

Again the commercial sector follows the residential sector in total demand with government accounting for the remainder. Here, however, government is responsible for a larger share of the total (21 percent), than was the case with electrical energy. This does not include government owned or operated housing included in the residential account.

In terms of overall Yukon energy consumption, the residential sector accounts for about 36% of Yukon consumption. However, in the smaller remote communities, residential requirements may account for 60% or more, since the commercial and industrial sectors are relatively small or non-existent. As would be expected, the industrial demand is quite localized in Faro, Keno/Mayo and Whitehorse and the commercial demand is concentrated in Dawson, Whitehorse and Watson Lake. Government requirements also are concentrated in Whitehorse. For the remaining communities, residential and educational plus a small amount of commercial and/or other government demand would be typical.

Total Yukon energy demand, excluding the transportation sector, is estimated at close to 4,000 TJ or the equivalent of 100 million litres of oil each year. About 1,200 TJ of this demand is already met by hydroelectric energy sources, leaving a demand for about 70 million litres of oil.

3.1.2 End-Uses

Excluding industrial process requirements, by far the largest end-use for all sectors is space heating and residential buildings account for the bulk of the space heating. Energy requirements for space heat depend on a number of climatic, lifestyle and building parameters.

It can be expected that essentially similar buildings could in fact exhibit a high degree of variability in their space heat requirements. A convenient way to compare buildings is on the basis of kilojoules per cubic meter per degree day ($KJ/M^3/DD$). This performance index standardizes for the variables of building size and climate, and can be used to draw comparisons throughout the study area.

Table 3-2 indicates the space heat requirements found in several groups of residential buildings. While the spread between the highs and lows is quite large instances, the means fall into more manageable groupings. For example, the means for row houses, duplexes and single family houses fall between 40 and 58 $kJ/m^3/DD$. The extreme high values arise when houses surveyed for the Pioneer Grant program that reported supplemental wood heating are included. These houses consumed much more energy than the non-wood heated houses probably due to

TABLE 3-2

RESIDENTIAL SPACE HEAT REQUIREMENTS

	KJ/M³/DD		
SAMPLE	**Low**	**Mean**	**High**
YHC Apartments (Whitehorse)		70	
YHC Row Houses (Whitehorse)	27	52	74
YHC Duplexes (Whitehorse)	32	47	69
Faro Row Houses	38	45	57
Faro Single Trailers	78	97	115
Faro Double Wide Trailers	66	80	94
Faro Single Family Detached	28	40	62
Pioneer Grant Houses (Whitehorese)	18	58	138
Pioneer Grant Houses (excluding those with wood)	18	50	100

Calculated Values:

R7/R7 - single glazed, 1.5 a/c	137
R20/R12 - double glazed, 1.0 a/c	70
R28/R20 - double glazed, .5 a/c	38

Insulation		Window Glazing	Air Changes per hour	KJ/m³/DD
Roof	Walls			
R7	R7	single	1.5	137
R20	R12	double	1.0	70
R28	R20	double	0.5	38

large conversion losses. When the wood burning households are omitted, the average falls to 50 KJ/M^3/DD. The Faro, Federal government and Yukon Housing Corporation (YHC) dwellings indicated in the table rely almost exclusively on fuel oil for space heating.

For comparison purposes, heat requirements for three types of houses with typical insulation levels for ceilings and walls were calculated using the methods developed by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE). As can be seen, the R28/R20 house is calculated to perform slightly better than the Faro single family detached houses. Duplexes, row houses and the Pioneer Grant houses fall between the R28/R20 and R20/R12 standards. Only the most inefficient house in the Pioneer Grant sample matched the expected performance of a R7/R7 house.

To estimate energy demand for residential space heating, 50 KJ/M^3/DD is probably an appropriate figure for detached units as well as row houses. This is higher than the Faro figures but many of the houses in Faro were built in 1980 and are better than the Yukon average in terms of thermal performance. For mobile homes, an average of 85 KJ/m^3/DD is suggested.

It should be noted that these figures represent gross energy demand assuming 39.5 MJ per liter of fuel oil. If average seasonal oil furnace efficiency is about 60%, then the net usable energy required would be about 30 KJ/M^3/DD. When considering alternatives such as wood or electric heating, it is this net demand that the technology must satisfy.

About one-third of the residences in the Yukon, however, do not use oil as their primary source of space heat. Table 3-3 indicates the breakdown of principal heating fuels in the residential sector. In the larger centers, oil is clearly the dominant heating fuel, followed by electricity. Virtually all of the electric space heating is in Whitehorse.

In the smaller communities, wood is the primary source of space heat. The figure of 56% here is largely influenced

TABLE 3-3

RESIDENTIAL SPACE HEATING FUELS

Fuel	Communities <250	Communities >250	Communities Yukon
	%	%	%
Oil	36	70	64
Propane	2	2	2
Electricity	6	19	17
Wood	56	10	18
Total Residences	1,240	6,260	7,500

Source: Statistic Canada, 1981 Census Data.

by native communities where nearly all the residences are heated by wood. Table 3-4 provides the results of a survey of wood usage in native communities conducted for this study.

The next largest use category, after space heating, is also attributable to the residential sector. Lights, appliances, hot water heating and cooking consume about 50 GJ per year per household based on the survey data discussed above and electric company records. Nearly half of this total is for water heating. This energy consumption tends to be a function of persons in the household rather than size of building or climate. Electricity is the principal energy form used for these purposes.

In non-residential sectors, lights and heating tend to be the only significant end uses in private and government office buildings, retail outlets and storage buildings. Hot water and cooking however, are important in food service and tourist accommodation businesses.

Residential space heating and electricity generation are by far the most significant consumers of fuel oil. Residential electricity is commonly supplied by diesel powered generators in many of the smaller communities. Hence, the most significant opportunities for reductions in oil consumption will arise in the residential sector. However, the small size and dispersed nature of individual residential units may make demonstrations of retrofit technology more economically attractive on larger commercial or institutional buildings, or on multifamily dwellings.

It should also be noted that in many Yukon communities, government owned housing makes up a very large proportion

TABLE 3-4

WOOD ENERGY USE IN YUKON NATIVE COMMUNITIES 1982-83
SOURCE: Band Representative interviews by Eric Morris, Skookum Jim Centre

Community	# Hshlds total	# wd htd hshlds	Band cds/yr	# Hshlds supplied	Avg cds / hshld	Hshld cords	Other wd used	Est total	GJ @14/cd	Type of wood
Whitehorse	80	40	390	33	12	473		473	6618	fkl spruce
Teslin	35	35	300	18	17	583		583	8167	spruce,pine
Haines Junct.	88	88	963	68	11	963		963	13482	fkl spruce
Ross River	45	30	440	15	29	880		880	12320	firekill
Dawson	24	15	110	15	7	110		110	1540	fkl spruce
Pelly Crossing	50	50	200	20	10	500	150	650	9100	firekill
Carcross	40	40	250	12	17	680		680	9520	
Upper Liard	55	55	740	25	30	1628		1628	22792	fkl spruce
Old Crow	95	85	700	85	10	850	200	1050	14700	fkl spruce
Mayo	55	45	350	30	12	525		525	7350	firekill
Carmacks	45	45	380	20	19	855		855	11970	pine,spruce
Burwash Lndg.	20	20	220	11	17	340		340	4760	dry spruce
AVERAGES	50	46	423	31	16	719	175	751	10518	
TOTALS	552	508	4653	339	179	7914	350	8264	115701	

of the total number of residences. When YTG and Federal holdings are considered together, it is clear that "government" plays a very significant role in the energy consumption profile of many of these communities.

3.1.3 Consumption Patterns

Variations in the level of energy demand through the year are largely influenced by climate conditions and daylight hours. As would be expected, the combination of the coldest temperatures and least daylight during the winter, causes energy demand to peak at this time. Space heating demand is the most variable since it changes in direct proportion to the number of degree days. In contrast, communities such as Beaver Creek and Dawson experience the greatest demand for electricity in the summer due to tourism activity.

Table 3-5 provides the monthly degree day normals for the study communities. As can be seen from the table, the range of annual degree days in the Yukon extends from around 6,900 in the Whitehorse area to 10,200 in the Old Crow area. January is the coldest month for all locations and as a result, peak heating loads can be expected during this month. July represents the minimum heat demand. In general the ratio of the maximum degree days to the minimum ranges from about 11 at Old Crow to 6 at Whitehorse. Most of the communities in between exhibit ratios of about 8 or 9:1. Average July degree days are about 150 which translates to an average daily temperature of about 13°C. Few buildings would require significant amounts of heating during that month. Many office complexes, however, will have cooling loads due to solar and internal heat gains, and inadequately managed and/or serviced mechanical systems.

The lighting component of the electrical demand will fluctuate with the seasons more or less in direct proportion to the hours of daylight. During the summer, when there are only about 5 hours of darkness, few households will be lit to any significant degree since the occupants will be asleep. During winter, lights will be required in all buildings from mid-afternoon through till mid-morning except when occupants are asleep. Energy demand for end uses such as cooking and household appliances would not be expected to fluctuate a great deal during the year.

Based on Yukon Electrical Company Ltd. records for a number of communities, typical January demand for electrical service ranges between 2.2 and 2.5 times July consumption. While there is some electric heating reflected in this differentiation, it is considered that the bulk of the variation is due to changes in lighting. Some uses for

TABLE 3-5

YUKON COMMUNITY DEGREE DAY NORMALS 1951-80
SOURCE: Atmospheric Environment Service, Environment Canada

	JY	AG	ST	OC	NV	DC	JA	FB	MR	AP	MA	JN	YR
OLD CROW	132	227	454	824	1253	1440	1560	1352	1330	892	526	216	10206 ******
BEAVER CREEK	156	214	394	741	1097	1400	1463	1122	1010	630	397	213	8837 *****
KENO	271	341	499	750	905	1079	1137	900	989	756	530	309	8466 *****
DAWSON	79	158	346	682	1044	1365	1509	1163	1018	589	324	131	8408 *****
FT SELKIRK (PELLY)	102	175	345	644	1004	1379	1477	1126	956	553	334	156	8251 *****
BURWASH	177	235	385	655	945	1241	1306	1017	960	612	406	233	8172 *****
ELSA	122	219	387	710	1010	1218	1331	1007	941	634	347	166	8092 *****
MAYO	93	170	345	634	1005	1308	1457	1070	920	552	324	143	8021 *****
CARMACKS	113	177	343	623	960	1309	1434	1058	911	540	338	165	7971 *****
WATSON LAKE	102	153	313	564	960	1285	1385	1036	908	557	343	161	7767 *****
HAINES JUNCTION	172	224	356	594	905	1191	1259	949	869	558	391	232	7700 *****
KLUANE LAKE	175	222	359	615	852	1146	1212	960	923	598	393	234	7689 *****
FARO	138	181	328	577	962	1229	1317	967	870	563	339	164	7635 *****
SWIFT RIVER	208	M	M	M	873	1095	1189	920	885	628	420	M	M
JOHNSONS CROSSING	152	203	333	555	825	1103	1245	926	824	558	372	210	7306 ****
TESLIN	144	194	330	544	820	1085	1228	906	819	557	379	207	7213 ****
WHITEHORSE AIRPORT	124	173	315	538	804	1073	1200	882	811	532	352	183	6987 ****
CARCROSS	150	194	319	512	790	1024	1164	880	808	535	376	213	6965 ****
WHITEHORSE RIVRDLE	112	161	305	518	821	1094	1204	874	782	508	340	174	6893 ****

electric power, such as appliances, cooking, and commercial space lighting are not influenced by seasons to a great extent.

Commercial consumers of energy have heating requirements directly proportional to degree days but lighting tends to be used in commercial businesses whether daylight is available or not. In some cases, the heat gains from electrical loads supply a significant portion of space heating requirements.

3.2 ENERGY SUPPLY

3.2.1 Non-Renewable Resources

About 75 million liters of refined petroleum products are consumed in the Yukon each year outside the transportation sector. Ninety percent of this volume is in the form of heating oil for thermal energy requirements while the other 10 percent is used as diesel oil for electrical generation.

Propane is used to a minor extent in the residential and commercial sectors for space heating and cooking. It is a major source of energy in mining camps and some highway lodges. The price of propane is only a few cents per liter less than fuel oil, but it has only 69 percent of the energy content. This acts as a disincentive to more propane use. If the price of propane more closely represented the energy value, then it could be a significant substitute for oil.

Coal is a major non-renewable resource used in the Yukon. Historically, it has been produced from a number of sites, the most significant being the Tantalus Butte Mine near Carmacks. All of the output from this mine was utilized by the Cyprus Anvil mine at Faro. During normal operations, Cyprus Anvil requires 20,000 tonnes per year to operate 4 coal fired boilers for heating at the minesite and by 4 coal fired ore concentrate dryers. One additional ore dryer uses fuel oil (551,290 liters in 1980). The Tantalus Butte mine has recently been abandoned, however. There is a lack of demand with Cyprus Anvil closed down and the underground coal seams in the mine are burning. The depth of the overburden makes stripping uneconomical and it is unlikely that Tantalus Butte would be reopened.

Only a few minor, non-industrial uses of coal were found in the course of this study. Coal was used for the central heating plant in the Takhini area of Whitehorse until the boilers were retrofitted for fuel oil in the 1940's. This federally owned and maintained complex could serve as a application site for a coal fired central heating system. Whitehorse Coal Company is in the process of developing a new anthracite coal property near Whitehorse. Supply to

Cyprus Anvil is the chief marketing objective of the company but marketing to large buildings is under active consideration. The coal resource being developed is reportedly low in sulphur content and would be suitable for space and water heating uses in large institutional and commercial buildings.

3.2.2 Renewable Resources

Hydroelectric power represents the largest exploitation of renewable resources in the Yukon. The present generating capacity on the Aihishik-Whitehorse system is 70 MW. In addition, Yukon Hydro has about 1.6 MW of generating capacity on McIntyre Creek which is fed into the Whitehorse System. An isolated hydro system operates at Mayo with a capacity of about 5 MW. Hydro power supplies about 85% of the total Yukon electrical demand, or about 1,300 TJ (360,000 MWh).

Wood is growing in its importance as a supply of energy and has already made significant inroads in terms of replacing oil in residential space heating applications. Accurate data on current wood use are not available. Stone and Webster (1983) recently researched the issue and concluded that about 40% of Yukon residences derive at least some of their space heat from wood. A 1982 survey conducted by EMR and Environment Canada of the Riverdale district of Whitehorse found wood burning appliances in 34% of the homes. This survey also determined that the average consumption by a household using wood as a supplementary fuel is about 4 cords per year.

Quantification of wood consumption is often difficult due to differing perceptions among consumers as to what constitutes a "cord". For this study, a full cord is defined as 2.26 m^3 of solid wood with a weight of 1,000 kilograms. The average energy content is assumed to be 16 GJ per cord with an average moisture content of 15 percent. When less precise uses of the term "cord" are necessary in this report, the word will appear in parentheses.

Assuming 40 percent of the households burn 4 cords each, and an average combustion conversion efficiency of 35%, wood is estimated to meet about 10% of the total space heating requirements of the residential sector.

A wood chip-fired boiler is being used for space and water heating in the new school building at Pelly Crossing and the school at Old Crow uses approximately 200 "cords" of wood per year. A privately owned sawmill operation in Watson Lake uses chips and mill wastes to generate electricity and space heat. Other than these three examples, wood use is not common in the commercial or government sectors. Total current harvest of wood in the

Yukon, according to DIAND figures, amounts to 107,672 solid cubic meters having an energy content of approximately 762,000 gigajoules. It must be assumed, however, that much of this wood is not harvested for fuel purposes. This volume represents about 4.9 percent of the total annual allowable cut in the Yukon.

Solar energy is used in passive applications by many buildings all over the Yukon, although few buildings have been designed to maximize solar gains. Active solar water heating systems are in use for municipal pools at Mayo and Carcross.

Geothermally warmed ground water used for freeze protection of the water systems at Whitehorse and Mayo is another significant use of renewable energy resources.

3.3 ENERGY PRICES

With the exceptions noted concerning subsidies and equalization payments, in Section 3.4 which follows, most Yukon customers pay market prices for their energy supplies.

All forms of energy currently available, with the exception of self-supplied wood, are relatively expensive when considered on an "after conversion" basis.

For comparing energy supply alternatives, it is necessary to evaluate the system on the basis of the cost per net usable unit of energy. Table 3-6 provides comparative figures.

It is clear from the table that wood is the least expensive form of energy followed by hydroelectric power. Diesel electric power, however, is more than twice as expensive as any other alternative. The high end of the range for diesel electric prices would be Johnsons Crossing, where the price per kWh is 53.65¢. This would provide a net energy price of $149 per GJ, with a diesel conversion efficiency of only about 18 percent. Old Crow has the highest fuel cost (63¢ per liter) but better efficiency at about 27 percent.

To fully evaluate any oil reduction project that would have the support of federal funding, (including RCDP projects) the procedures of the "Implementation Manual for Off-Oil and Retrofit Programs (1982)" issued by Energy, Mines and Resources Canada, should be followed. This manual suggests that the cost of off-oil projects should be compared against the value of oil savings to the Canadian economy rather than just the monetary savings of the oil consumer.

This is accomplished through the application of "crown premiums" to the market prices of oil savings. These crown

TABLE 3-6

COMPARATIVE ENERGY PRICES

Energy Type	Price Range	Energy Input Price ($ per GJ)	Typical** Conversion Efficiency (%)	Net Energy Price ($ per GJ)
Fuel Oil	40-63¢/l	$10.13-16.15	60	$16.88-26.92
Propane	38-50¢/l	$15.20-20.00	75	$20.26-26.67
Wood	$60-110/cord	$ 3.75-6.88	40	$ 9.37-17.19
Hydroelectric	5.3-9.6¢/kWh	$14.72-26.66	100	$14.72-26.66
Diesel Electric*	16-54¢/kWh	$44.44-149*	100	$44.44-149.00

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* Diesel electric prices are taken from actual NCPC rate schedules. The diesel conversion efficiency of an average 28 percent is already included in the price. The 100 percent conversion indicated is the end use efficiency.

** Conversion efficiencies represent seasonal efficiencies, not steady state efficiencies.

premiums adjust for the fact that market prices of oil are "blended prices", representing some domestic and some imported oil. However, the true marginal price of oil to the Canadian economy is the price of imported oil since this is what would be displaced by oil reduction measures. EMR suggests that the "crown premium" factor be calculated by adding 9.2¢ to the market price of oil and dividing by the market price.

For example, if an RCDP program were to displace a liter of oil costing 45¢ per liter, the true savings would be:

$$\frac{.45 + .092}{.45} = 1.2$$

or 20 percent greater than simply the cost of the oil.

3.4 INCENTIVES, DISINCENTIVES AND GOVERNMENT ROLES

A wide range of influences operate on energy consumers to either encourage or discourage the use of oil relative to what they would have done in the absence of such factors. Economic pressures can be expected to have the greatest impact on consumer decisions with respect to energy consumption.

Most Yukoners are feeling the bite of high fuel prices. By the end of the 1982-83 heating season, fuel oil prices ranged from 40 to 63 cents per liter, compared to about 38 cents in Vancouver and less in Alberta. Therefore, the economic incentive to do something is real.

3.4.1 Conservation Education Programs

In recent years, Federal, Territorial and Provincial governments, as well as the private sector, have produced a wealth of written and visual information on energy conservation. Many people, however, still do not know where to start. In the future, consumer education will become the single greatest factor in determining the implementation of appropriate energy conservation measures. In the Yukon, since 1982, courses have been presented to contractors, carpenters and individuals training to be residential energy advisors. Public seminars on a variety of energy conservation topics have been presented to interested householders. This public information transfer has operated in conjunction with ongoing advisory services offered by the Federal and Territorial government energy conservation offices.

At the present time, Yukon College, through its Education Extension Services is developing courses on householder energy conservation and basic home repair, with an emphasis on energy conservation, to be presented in communities throughout the Yukon beginning in 1984. In addition, the Whitehorse based Energy Information Centre has organized the annual Yukon Energy Saver Festivals with product displays and workshops.

All of these public education services will enhance the level of consumer awareness, and provide the public with practical techniques for implementing energy conservation measures.

3.4.2 Energy Audit and Survey Programs

To provide energy conservation advice at the individual building level, Energy Mines and Resources is sponsoring programs to provide free energy audits and energy conservation information to householders in approximately 10 percent of the homes in the Yukon. YTG Energy Branch administers the Yukon Energy Conservation Initiatives Program under CREDA agreements and with the assistance of federal funding. Free building audits are performed for commercial consumers who apply. Federal funds, administered by YTG, are also available to assist commercial building owners to help defray the costs of energy conservation measures.

3.4.3 Energy Conserving Retrofit Demonstrations

A number of residential retrofit demonstrations have been completed during 1983. These demonstrations have been funded by a combination of CHIP, COSP, and RRAP grants with additional funding provided by the CREDA program administered by the Territorial government Energy Branch. Public awareness of these demonstration projects should provide additional incentives to implement energy conservation.

The Energy Mines and Resources Remote Community Demonstration Program also offers the opportunity to provide significant incentives for implementing energy conservation in communities throughout the Yukon.

Although not demonstrated per se, government agencies such as Indian and Northern Affairs, Public Works Canada, Yukon Housing Corporation, YTG Highways Department and the City of Whitehorse have begun to retrofit buildings which they maintain.

3.4.4 Economic Incentives and Disincentives

The rising cost of energy is probably the greatest incentive for energy conservation. Most householders in the Yukon are directly responsible for the cost of energy in the home. Where the user pays directly, there is a correspondingly direct incentive to conserve.

Increased operating costs should also motivate the industrial, commercial and government sectors to seek ways of reducing energy waste. Federal, Territorial, and Municipal governments are beginning to recognize the benefits of including energy conservation in building operation, maintenance, and renovations.

One disincentive to conservation, in the industrial and commercial sectors, occurs due to the tax deductibility of energy expenditures as operating expenses. For example, for a firm paying 45 percent in taxes, the after tax cost of energy puchases is only 55 percent of the outlay. This effectively "shields" the firm from the full brunt of energy price increases. Another disincentive to energy conservation at the user level occurs where the government, industrial, and commercial sectors maintain staff housing, pay for energy, and offer significantly reduced rental rates as an encouragement to attract and keep employees in remote communities. As a result, these individuals have no incentive whatsoever to reduce oil consumption. If these sectors implemented policies to require house occupants to pay directly for their own energy, then there would be an incentive to conserve. This would significantly affect the residents of the 370 Federal government houses in the Yukon. Under present policy, the resident pays a fixed rental rate based on the size of the dwelling. This rental rate seldom covers the total cost of energy the residents use. The residents of approximately 600 mining company houses would also be directly affected if a user pay system was implemented. Under present union agreements, employees pay a decreasing percentage of the energy cost of their residence based upon number of years with the company. Both government and private sectors are seeking ways to change the present policies.

Cyprus Anvil has implemented an energy conservation incentives program in fiscal year 1983-84 for the 500 houses which they own and maintain. An energy budget has been calculated for each dwelling, based on historical averages for that type of dwelling. At the end of the fiscal year, the dollar difference between the budgeted amount and the actual consumption will be computed. The employee will then receive 50 cents for every dollar less than the budgeted amount. The company is also considering energy conservation education to assist householders and maintenance persons with the implementation of energy conservation measures.

Although 45% of the dwellings in the Yukon are rental units, in most cases the tenants are directly responsible for the cost of fuel and electricity. Apartments comprise 13% of the dwellings in the Yukon. In most of these, the landlord is responsible for the cost of fuel and electricity, while energy costs are hidden from the tenant in the rent amount. The increasing cost of energy has given public and private landlords an incentive to change policies relating to energy payments such that tenants are charged according to their usage.

Some private landlords of multiple dwelling units are now modifying electrical and heating systems to transfer the cost of maintaining common areas to tenants. Often these modifications are undertaken in conjunction with energy conservation measures and changes in dwelling access. Recent decreases in population and the general condition of the economy are encouraging some landlords to implement energy conservation measures to increase comfort and tenancy. There is also a trend to transfer the direct cost of heating fuel to the tenant wherever possible.

The Yukon Housing Corporation owns and maintains approximately 400 dwellings. Nearly all Yukon government staff in Yukon Housing Corporation (YHC) dwellings are responsible for the cost of electricity and fuel. Other YHC dwellings are rented to individuals at a rate determined by a percentage of income. For each dwelling, YHC has determined energy quotas. Fuel quotas are based on floor area, age of dwelling, condition, insulation levels and relative climate. As dwellings are retrofitted to improve energy conservation, the fuel quotas are adjusted. Previously, electricity quotas were determined by average use. Electricity quotas are now based on requirements for domestic hot water and furnace motor only. Any use above the quotas are paid for by the tenant.

Various types of equalization programs in the Yukon may be operating at cross purposes to conservation incentives. The residential fuel oil rebate program, funded by the Government of Canada, allows homeowners to apply for a refund of the difference between what they pay in outlying communities and the price of heating oil in Whitehorse. Basically, the transportation and administrative costs of supplying oil outside Whitehorse are being subsidized. As a result, the pressure on the consumer to reduce oil consumption is lessened.

A similar program is in place for commercial electricity customers outside Whitehorse. Here, the subsidy encourages oil reductions if the electricity is hydro generated. Where electricity is diesel generated, however, the rebate program has the effect of subsidizing more oil consumption.

Department of Public Works policies are undermining oil substitution efforts in federal buildings. Although at least one federal forestry office would like to install wood heating fixtures in federally maintained residences, DPW bars the use of wood stoves in all federally owned buildings. While this policy is currently under review, it clearly runs counter to the conservation objectives of the government.

Cross subsidization is apparent in the way the electric utility companies are regulated. NCPC and YECL have operating deficits in many of the "diesel" communities, which must be made up by revenues from grid connected communities. Again, consumers are being protected from the full costs of their energy consumption in diesel communities while some conversion to electricity in hydro communities is deterred by the higher prices caused by subsidization. If oil reductions were the primary objective, electricity prices should be set as low as possible in areas served by hydro power, while prices should reflect the full costs of production in communities with diesel electricity.

Economic incentives for fuel substitution can also reduce the use of oil. In the Yukon, such options would include wood, propane or coal. Financial assistance for off-oil fuel substitutions is available through the EMR COSP program. In the Yukon, most COSP applications are used for the purchase and installation of wood stoves, although the funds may also be used for oil furnace efficiency upgrading, insulation, and air sealing.

It should be noted that conversion to wood heating does not necessarily conserve energy, though it may conserve oil. The availability of the resource, the oil and gas used in gathering it, and the labour input for gathering, stoking, adjusting, and chimney cleaning should be included when considering the economics of oil to wood conversion. It is highly recommended that programs and incentives be directed first at reducing the requirement for energy through thorough conservation measures before the alternative source, be it wood or any other, is installed. In this way the appliance can be accurately sized to the probable long term demand of the building and optimum efficiency can be gained from the system.

Some concern has been expressed by consumers that the government COSP subsidy program has resulted in the near doubling of the cost of woodstoves over the last few years. Logic dictates that the cost of woodburners should have decreased since the manufacturers are now producing a much greater volume of stoves than they were previously. Part of the problem appears to be that manufacturers have been able to increase prices to absorb some of the COSP subsidy, but the subsidy itself is not linked to any standards for efficient, easily controlled, nonpolluting wood stoves.

There are two possible approaches to this problem. As an initial measure, the Federal government could inform consumers as to the efficiency of the appliance. Ratings for each COSP eligible stove or furnace could be developed using a similar method to the ENERGUIDE program. Three criteria could be used:

- Average duration of full load burn;
- percent efficiency during average burn; and
- index of pollution produced.

The pollution index would indirectly warn consumers of stoves which would be heavy creosote producers.

To further encourage the development of wood stove technology, the Federal government could initiate a design competition for efficient wood stoves. An award would be given to the manufacturer which designed the most efficient stove for a competitive retail cost.

Despite the problems, wood fired heating has a significant potential for reducing the requirements for oil in the Yukon. Existing problems with wood smoke pollution and chimney fires, would be solved if more efficient wood stoves were widely used. Recent experience with certain wood stoves suggest that long term burn cycles and efficient combustion are not necessarily mutually exclusive. Stoves designed with remote electrically operated thermostats can substantially improve efficiencies. As well, catalytic combustors could be added to existing stoves to improve secondary combustion. The opportunity exists to increase efficiency and thereby reduce pollution. It is recommended that Federal government incentives which affect off-oil fuel substitutions address these issues.

Most of the emphasis of the COSP program has been on substitution with wood. Propane also offers signficant potential for replacing oil and although it is not a renewable resource, it is relatively plentiful in Western Canada. Pricing agreements between the federal government and the provinces, and the less developed distribution system for propane, combine to price it higher than its energy value would dictate, however. Consideration should be given to directing the oil rebate subsidies toward lowering the price of propane. Then the program would have the dual benefit of lowering energy costs to the consumer and reducing oil consumption.

3.4.5 Energy Efficient Building Standards

Energy Mines and Resources and HUDAC have combined to introduce the "R-2000" incentives program for builders. Under this program builders may become eligible for a grant of $6,500 to defray indirect costs incurred in building energy efficient houses. Builders costs for advertising and mandatory air tightness tests, are also covered by this grant. Response to this program by builders has been very positive across Canada and in the North. Four grants were slated for the Yukon and three builder applications have been approved to date - one in Watson Lake and two in Whitehorse. Houses built under the program form a significant proportion of the housing starts in the private sector in the North at a time when the residential construction industry is at a virtual standstill.

EMR, CMHC, and DIAND have combined to bring together a group of northern designers, builders, consultants and government building technologists and regulators to produce "The Northern Residential Standards For Energy-Efficient Housing". This standard is expected to be in place for the 1984 building season. The standard will apply to all residential buidings being constructed with Federal Government financial participation in the NWT, the Yukon and northern locations in the Provinces. It has still to be established if this will include housing built with CMHC insured mortgages.

The implementation of such a standard, even if only for Federally funded Government residential buidings, will become a significant factor in affecting future directions for the residential building sector in the North. As trades-people become trained and confident in the new technology and consumer awareness grows it can be expected that demand for this type of housing will increase.

4.0 OVERVIEW OF COMMUNITY OFF-OIL OPTIONS

4.0 OVERVIEW OF COMMUNITY OIL-REDUCTION OPTIONS

4.1 CONSERVATION OPPORTUNITIES

Immediate reductions in oil consumption can be achieved in all Yukon communities through simple conservation measures, both on a single residence and community wide basis. Energy conservation refers to the prevention of unnecessary loss of energy. Those areas where the greatest savings are likely to be made in individual buildings are in space heating and hot water heating. The heat input required to maintain a building at a desired temperature must balance the rate of heat loss. The rate of heat loss is a function of the difference between inside and outside temperatures, the surface area of the building, and the effectiveness of the insulation, the building envelope and the lifestyle of building occupants. Wherever oil or diesel-generated electric energy is used for space heating, significant reductions in oil consumption can be achieved through better energy management techniques. These require little or no investment but in many cases require effective dissemination of public information on appropriate actions.

Energy management and conservation requires an awareness by householders and other building operators of the sources of energy waste or loss and the methods available to control these. Typical energy management options for reducing energy consumption available to individuals include: lowering indoor temperatures, especially at night, minimizing hot water use, lowering hot water tank temperatures, cleaning and adjusting furnaces, weatherstripping, sealing cracks and gaps, keeping windows and doors closed during the heating season, and turning off lights and appliances when not in use. It can be assumed that growing public awareness and the high cost of energy will serve to bring about the implementation of most of these measures.

The introduction of more efficient equipment or better controls can also conserve energy. Examples are energy efficient appliances, timers or thermostats on engine block heaters, high efficiency furnaces, light dimmers, furnace automatic set-back controllers and window blankets.

All of the conservation opportunities mentioned in this section rely on proven and generally available technologies. It has been noted, however, in the course of this study that economic incentives can play an important role on the level of implementation of such measures. Conservation is not likely to be practiced unless the individual can expect to receive some form of direct benefit, either financially or by way of improved living conditions. To the extent that individuals either do not pay the full cost of their energy consumption, or are not fully aware of the full costs of their energy consuming patterns, appropriate levels of conservation will not be achieved.

Certainly, it can be expected that there is a far greater appreciation of the importance of energy management in recent years due to the high cost of energy in combination with the long Yukon heating season. No reasonable means have been discovered in the course of this study to quantify the extent of energy conserving practices already in use by Yukoners. Without knowing the present state of conservation, it is not possible to determine what further gains may be available. Clearly, more can be done but the magnitude of the oil savings that could result is uncertain. Only through an extensive building energy survey program, would it be possible to generate a ranking of conservation opportunities in remote communities in the Yukon. Residential audits being conducted in 1983-84 may help indicate the economic impact and extent of conservation measures. In the absence of this specific data, however, it is reasonable to assume that the average heating cost of Yukon residences could be reduced from 150 GJ to 100 GJ per annum with the application of proven conservation techniques. At $10 per GJ (1983 fuel oil price) this amounts to $3,750,000 annually for the 7,500 dwellings in the Yukon. Three areas of conservation however, require further discussion, namely, reducing air leakage, insulation retrofitting and waste heat recovery. These are discussed in the following sections.

4.1.1 Insulation and Air-Vapour Barriers

Only very recently constructed buildings in the Yukon have been fitted with efficient air-vapour barriers or levels of insulation which would be appropriate for the climate.

In older buildings the best means for reducing space heating energy requirements involves the sealing of air leaks in the building envelope. Typical areas of air leakage are at the sill plate between the walls and foundation, where plumbing stacks and electrical wiring penetrate the ceiling, through wall plugs and switches, and around windows and doors, including the attic hatch. Air leakage around windows and doors can be a major source of heat loss in residential buildings. When combined with the low thermal resistance of windows and doors, the percentage loss can be from 30 to 50 percent of total building losses, depending on other insulation levels. Losses associated with windows and doors originate from two sources:

- direct, radiant and conductive losses through the materials, and
- infiltration of cold air through cracks and spaces around the perimeter of the openings.

Direct losses through windows can be best reduced by double or triple glazing, by installing storm windows, by providing inside shades or drapes, or by various combinations of the above. Losses can be reduced four fold by triple glazing plus storm windows as compared with single glazing. Losses through doors can be reduced by exchanging hollow core doors for solid core and by adding well-fitted storm doors or vestibule entry ways. Losses associated with air leakage around windows and doors can be minimized by ensuring that the spaces between wall openings and window or door frames are well sealed and caulked. Weatherstripping should also be installed around all doors and operable windows.

The next major means of reducing oil consumption is by insulating areas of the building envelope which have no insulation such as exposed concrete foundation walls or exposed floors. Additional attic insulation may often be the most cost effective energy conservation measure, provided thorough air sealing is undertaken prior to installing the additional insulation. Otherwise, moisture which condenses in the attic insulation can be responsible for structural deterioration through dry rot since the additional insulation inhibits the escape of moisture during warmer seasons.

A similar problem is created when less than 4" (RSI 3.5) of styrofoam insulation siding is added to the outside of insulated walls. Less than 4" is not enough insulation to prevent the condensation of moisture on the inside surface of the styrofoam. The trapped moisture can result in degradation of the building structure during the warm months.

If the building has 3.5 inches or less insulation in the walls then the application of a full air barrier wrap and a minimum insulation retrofit of R20 (RSI 3.5) can significantly improve the building's thermal performance. In nearly every case, fibreglass is the most economical insulation material.

A number of major retrofit projects which involved the complete renovation of exposed foundations, exterior walls and roof to increase the available insulation space have been undertaken in the Yukon during 1983. Retrofit costs range from $4 to $8 per square foot of surface area depending on the individual contractor and the number of windows replaced. At the end of the 1983-84 heating season, energy use information will be available to compute the benefits of these installations.

The overall application of thermal insulation in Yukon buildings could not be documented in the course of this study. Therefore it is not possible to calculate the oil savings which could be achieved through insulation retrofit or the economic return which could be expected from insulation retrofit investment. One estimate of the attractiveness of insulation retrofitting was made by Schaeffer et al (1983), based on survey findings from the Yukon Energy Conservation Incentives Program and EMR's Home Energy Programs Division. Average costs of energy savings ranged from "less than $1/GJ to just over $5/GJ" according to their calculations. When compared with net energy costs of about $17/GJ (assuming 65 percent oil furnace efficiency) such measures appear quite attractive.

4.1.2 Heat Recovery

Ten of the remote communities in the Yukon receive all of their electrical energy from diesel generators. These communities range from two of the largest, Dawson City and Watson Lake, to the smallest, Johnsons Crossing and Swift River. Yukon Electrical Company Limited reported that the yield from each litre of diesel oil burned averaged 3.16 kWh. The range was from a low of 2.0 at Swift River to 3.3 at Watson Lake. In general, the smaller communities have the less favourable conversion efficiencies. Diesel generator units convert only a small proportion of the fuel energy to electrical energy. For example, at 3 kWh/litre, the usable electric energy is only 10.8 megajoules from a litre of oil containing about 39 megajoules. This represents a conversion efficiency of about 28%. The remainder of the energy in the oil is usually lost as follows:

- approximately 30% as waste heat distributed to the jacket cooling water/radiator system;
- 30% to exhaust; and
- 10 to 15% in general radiation losses.

Waste heat recovery of both the cooling water and exhaust heat allows up to 80% of the fuel input energy to be utilized. Nearly all of the jacket cooling water heat and more than half of the exhaust can be recovered. Heat exchangers transfer jacket and exhaust heat to secondary cooling loops. These recirculation loops transport the heat energy to end use points. A jacket water waste heat recovery system can provide heat as hot water at up to 120° C or as low pressure steam (100 kPa, 15 psig). A higher temperature exhaust heat recovery system can provide hot water or, alternatively, steam at pressures up to 1,000 kPa (150 psig). Heat recovery providing high temperature hot water is the simpler system and is more commonly adopted.

With any arrangement of diesel waste heat recovery, the amount of productive heat available is dependent on diesel output which is in turn set by the electrical system load demand. Since electrical and space heating demands are not necessarily in phase, independent standby heating facilities are still required during periods of diesel shutdown, low loads and peak heat demands. On the other hand, to accommodate low or zero heat demands, a radiator or other exchanger is required for jacket cooling. One way of making use of waste heat in the summer is to heat a community swimming pool. Table 4-1 provides an indication of the waste heat available annually based on actual generation at diesel supplied communities in the Yukon. Since waste heat is available year round, while space heating requirements are seasonal, perhaps only 70% of the available waste heat could be effectively utilized.

Except in cases where steam is specifically required, full exhaust heat recovery systems can be quite complex and expensive. It would be more appropriate to incorporate a simpler secondary hot water loop designed to retrieve some of the exhaust heat into the jacket water recovery system. Such a system would be expected to recover all of the cooling water heat and about 50% of the exhaust heat, resulting in recovery of about 18 MJ per liter consumed by the diesel engine. This represents about 46% of the available fuel oil energy.

Even after adjusting the estimated usable energy for each community to 70 percent of the total, it is obvious that substantial energy is available in many communities. Indeed, in some of the smaller communities (Beaver Creek, Swift River, Destruction Bay) the usable energy exceeds the total residential space heating requirements.

Retrofitting of jacket waste heat recovery with an existing diesel system is generally readily accomplished. Ideally, a single or limited number of large users of heat, located in proximity to the diesel plant are available to minimize the scope and installation cost of the secondary loop hot water transport system. If the distribution system becomes too extended, the energy required for electrical pumps and the cost of piping installation will reduce the attractiveness of the system. It is likely that district-wide heating systems will not be appropriate in most communities due to the costs and construction difficulties. In general, the user building should be within about 500 to 1000 meters of the diesel set.

The community school, a large hotel/lodge or government facility, community hall or recreation center would be likely candidates for heat recovery systems provided they are located close to the diesel plant. In Dawson City, recovered heat is already used for freeze protection of the

TABLE 4-1

DIESEL WASTE HEAT AVAILABILITY

Community	Generation (1) (MWh/yr)	Recoverable Waste Heat (2) (GJ/yr)	Usable Energy (3) (GJ/yr)
Watson Lake	10490	56770	39700
Teslin	1774	10000	7000
Destruction Bay	1164	6780	4746
Beaver Creek	1114	6620	4630
Old Crow	690	4500	3150
Stewart Crossing	370	2690	1885
Pelly River	683	4730	3310
Swift River	239	2140	1500
Dawson	7451	35600	24933
Johnsons Crossing	33	590	410

Notes:

(1) YECL and NCPC records.

(2) Assumes 39 MJ per liter of which 12 MJ is recoverable from cooling water and 6 MJ from exhaust.

(3) Assumes 70% of recoverable waste heat is usable due to non-coincidence of heating and electrical demands.

water system and the heating of some row housing units. A plan to extend this system to include additional housing units is currently being investigated by NCPC and Yukon Housing Corporation.

The siting of future community buildings should take into account the possibility of waste heat use. Buildings with high heating loads (schools, large garages, health services) or high hot water demands (washhouses, laundromats, swimming pools) are most likely to find such systems economic. Since NCPC or YECL owns and operates the diesel sets, appropriate institutional and/or commercial arrangements should be established to fix prices and operating responsibilities on such systems.

4.1.3 Efficiency Improvements

As with general conservation measures, all communities could achieve energy savings through various techniques for improving energy conversion efficiencies. Probably the most common ineffeciency arises from poor wood burning practices. Households using standard fireplaces for supplementary heating may actually be requiring more oil for base load heating since the loss of warm room air up the flue can exceed the gains from wood combustion. It is likely that even buildings which have relatively efficient airtight wood burners achieve less than optimum results due to improper damping techniques. Often, users dampen the fire down to slow combustion so that the fire will last while the fire is unattended or to avoid the need for rekindling. The result is an oxygen starved smoldering fire, with much of the energy content of the wood going up the chimney as smoke. Furthermore, the combined effects of topography, climate and inefficient wood burning practices results in excessive levels of air pollution.

Improved efficiency requires more attention to the fire and therefore may be difficult to obtain unless users appreciate its economic value. Where buildings are heated solely by wood, improved efficiency results in less wood used. However, where wood is a supplement to oil, better wood use could result in oil savings.

A more direct efficiency improvement leading to oil reduction involves the cleaning and adjusting of the oil furnace by a qualified service person. As well, the retrofitting of an automatic stack damper and a high efficiency burner head can increase the seasonal efficiency of the oil furnace to as much as 80 percent, rather than the 55 to 60 percent normally associated with most oil furnaces. An increase in efficiency from 55 percent to 80 percent results in a saving of 30 percent of the oil to supply the same amount of usable heat.

A final key concern from a conversion efficiency standpoint arises from the use of electrical appliances and machinery where the electric power is diesel generated. On average, the conversion efficiency of a diesel generator set is less than 30 percent (3 KWh per liter). In many smaller communities, the conversion is closer to only 18 percent (2.0 Kwh per liter). While the end-use efficiency of electricity is 100%, there are still large losses in the overall system. Therefore, large net reductions in oil consumption can be gained by insuring that water heaters, space heaters, stoves and clothes dryers operate on oil or propane. The result would be an improved efficiency to about 65 percent for those end-uses, or conversely, a reduction in oil consumption of about 40 percent.

Where hydro-electric power is available, the reverse would be true. Here, the best way to reduce oil consumption and improve conversion efficiency is to encourage the use of electricity for space heating, water heating, cooking and clothes drying, if there is sufficient hydro capacity.

4.2 ALTERNATIVE ENERGY RESOURCE OPTIONS

4.2.1 Introduction

This section presents a summary of the various energy resource options and technologies suitable for remote communities in the Yukon. The evaluations given have specific regard to practical factors which affect their adoption. These factors include:

- resource availability and security of supply;
- proven state of the technology;
- skill levels required for operation and maintenance; and,
- costs.

Uses of the resource for both electrical generation and heating are considered as appropriate.

Comments regarding the competitiveness and suitability, or otherwise, of a resource for use at remote communities in general, can only be tentative under the broad scope of this study. Where a resource option looks promising at any given location, its adoption should be preceded by specific social and environmental impact assessment and technical and economic evaluations to verify the feasibility of the project.

A further caution is required when considering the advantages of any particular energy supply option. Alternatives should not be judged solely on the basis of the amount of oil they can potentially displace, but rather the amount which can be displaced after appropriate conservation measures have been taken. The economics of capital intensive energy supply systems will be quite sensitive to the anticipated levels of load demand. If more cost-effective off-oil options, such as conservation, reduce the overall demand, the economics of supply options will become less favorable.

4.2.2 Hydroelectric Power

Various studies of the Yukon have estimated the total hydro resource potential in terms of thousands of megawatts (see Monenco, 1976; Sigma, 1975; Schaeffer, 1983). Unfortunately, most assessments of the hydro potential have focused on very large scale projects which far exceed the indicated load demand in the Yukon. These large scale projects (50 MW and up) must be connected to a major grid network and are very expensive in terms of total cost. However, if the demand is there, hydro represents one of the best means for achieving quite low unit costs for energy and positive displacement of oil consumption.

With the addition of the new 20 MW generator at Whitehorse, there is actually a surplus of hydroelectric power available on the grid at the present time. Under normal circumstances, this situation would call for the encouragement of further use of electric energy to displace oil consumption. If the capacity is already installed, the incremental cost to society of using it is quite low. However, the Yukon situation is more complicated because of uncertainty about the future demands of the Cyprus Anvil Mine at Faro. When in operation, this mine utilizes about 125,000 megawatt hours per year. The installed capacity necessary to meet this demand is between 15 and 20 MW. This is about equivalent to the present surplus.

Therefore, it is unlikely that this surplus will be available in the long run, assuming the mines will re-open again. In the short term, however, it may be economic for some large consumers of oil for space heating to convert to electric element heating to reduce oil consumption as long as surplus hydro is available. This would depend on projections of how long the surplus will persist, what rate can be negotiated for electrical energy and the likelihood of recapturing the investment in electric heating equipment. Indeed, NCPC is encouraging the use of electric heat in larger buildings and has negotiated a relatively low price of 3.2¢/kwh for secondary, interruptible power in the hospital in Whitehorse.

If demand returns to normal levels, it is probable that the most cost effective means of reducing oil consumption in grid connected communities, after conservation, would be the installation of new hydroelectric generating capacity. If oil prices were to rise dramatically, it could be justified to encourage consumers on the grid to convert all their energy demands to electric - including space heating, water heating, all appliances, machinery and industrial processes. Such a move could displace over 80 percent of all oil consumed in the Yukon outside the transportation sector.

Examination of potential large-scale hydro sites for the grid has been conducted in a number of areas and such developments are beyond the scope of this study and the RCDP program. It should be noted however, that if hydro is developed in the future, it could become feasible to supply some non-grid communities depending on the location.

Of more particular concern in this study is the potential for small hydro to supply those communities that are currently dependent on diesel generation. To that end, a desk-top appraisal of potential small hydro sites proximate to the diesel supplied communities was conducted. (Note: Dawson was not included since future hydro will likely involve renovation of an existing site. Swift River was not included since demand is unlikely to justify any hydro development).

Very little emphasis has been given to the development of small hydro projects sized to suit individual remote communities. Industry definitions of what constitutes "small" hydro vary, but in the context of this report, facilities with a capacity of 5 MW or less would be considered "small" and would be in the size range appropriate for remote community loads. Indeed, for most communities in the Yukon, 1 MW or less would be adequate. This would be in the area of what is often termed "mini-hydro." "Micro-hydro" often refers to installations in the less than 500 KW range.

The physical size of small hydro facilities are completely site dependent. In general, the facilities would include a control structure, a penstock and a powerhouse. The control structure is basically a dam, of concrete or earthen construction, which holds back water to store energy. It would have controls for releasing water to the penstock or to the stream below the dam. The height of the dam will depend on the "head" available from the dam to the powerhouse. "Head" is the vertical drop the water makes as it passes through the penstock. If the head is large, the dam, all things being equal, can be low. If the available head is low, the dam must be higher to "create" head. The terrain of the site will also dictate dam size. A narrow canyon would tend to have a narrow, high dam while a broad valley would have the reverse.

As a rough estimate, it is unlikely that mini or micro-hydro sites requiring dams higher than about 25 feet would be economical.

The flooded area behind the dam would depend on the physiography of the area and the nature of the dam structure, but in general, an area comprising about 10 percent or less of the total drainage basin would be a reasonable estimate.

The penstock is basically a pipeline that carries water from the control structure to the generator turbines in the powerhouse. For small hydro, with typically small diameter and low flow penstocks, the pipe would probably have to be buried to avoid icing, given the Yukon climate.

The powerhouse is not very sensitive to size factors in small hydro installations. It would typically be a single room concrete or frame structure housing the generator units with the penstock entering one end and a water outfall to return water to the stream at the other end.

Of necessity, small hydro projects would have to be located quite close to the community to avoid excessive transmission line costs. Just as it is not economic to extend transmission lines from the existing grid to many of these communities, it would not be economic to have long distances between the community and a dedicated mini- or micro hydro plant.

In order to narrow the search for possible sites, it was necessary to establish a maximum radius from each community based on the costs of transmission. Overhead transmission lines (in the size range appropriate to small communities) can range from $30,000 to $60,000 per kilometer depending on size, terrain, access and clearing requirements. Based on an average transmission cost of approximately $50,000 per kilometer, the maximum economic radius for the search was taken as .25 kilometers per household in the community. For example, for a community with 50 households, it could be feasible to consider hydro sites up to about 12.5 (50 x .25) kilometers away. This was used as a rule of thumb to focus in on the study areas.

Within the search area for each community, topographic maps were examined to identify potential hydro sites. This search involved an iterative process of looking for sites having a combination of appropriate head and catchment area. Precipitation records were used to calculate estimated stream flows.

To minimize the unit costs on any hydro development, it would be necessary to maximize the load demand by switching all possible energy requirements to electric. This results in an assumed demand of about 50,000 kWh per household. Of course, commercial and government demands would add to the load but it would be expected that residential demand would represent the bulk of the consumption. To the extent that nonresidential load exists, hydro development would be even more economical.

Table 4-2 indicates the results of this investigation. As can be seen, the Faro area was included in the study because with the mine in operation, additional energy could be required here. Sites at Burwash Landing, Destruction Bay, Teslin, Ross River and Watson Lake were considered the most promising. It should be emphasized that a specific investigation would be required to fully determine the technical feasibility, social and environmental impact and cost of any given hydro development.

From the data available for this study, it was not possible to establish construction costs for any particular sites. To provide some indication of the relative costs of hydro development compared with the value of the oil displaced, an average of $4,000 per installed kilowatt was used. The capital cost column in Table 4-2 is based on this figure and applies to the total site capacity, which is in most cases greater than the required capacity.

The present value of oil savings calculated in the table is based on an average of 150 GJ per household, a 50 year project life, a 10 percent discount factor and no escalation in oil prices. With commercial and government savings added in and allowance made for increasing oil prices, the actual savings would be greater.

NCPC and YECL have also investigated small hydro sites suitable for serving some of these same communities. Five sites which have already been studied in some detail should be noted as possible oil reduction alternatives as well. The sites, along with approximate capacities, are as follows:

Squanga Creek - near Johnsons Crossing, 1.0 MW;
Morley River - near Teslin, 1.5 MW;
Mayo - below existing power plant, 2-3 MW;
Watson Creek - near Watson Lake, 2 MW;
McIntyre Creek #3 - below existing plant #2, 2 MW.

Four further considerations are appropriate in this discussion of hydro resources.

- Development of hydro power in the Teslin-Johnsons Crossing region may be sized such that there is

TABLE 4-2
DESK STUDY OVERVIEW OF SMALL HYDRO SITE POTENTIAL

COMMUNITY	NO. HOUSE-HOLDS	ANN. PRECIP-ITATION mm.	HYDRO SITE	GROSS HEAD m	DRAIN-AGE AREA km²	MEAN Q m³/s	PENSTOCK LENGTH m	PENSTOCK DIAM. mm	TRANS-MISSION LENGTH km	SITE CAPA-CITY kW	REQ'D CAPA-CITY kW	ENERGY AVAIL-ABLE MWh/YR	ENERGY REQ'D MWh/YR	C.C. HYDRO PLANT (1000's)	P.V. OIL DISPLACED ($1000's)	RANK	REMARKS
Beaver Creek	40	442	-	-	-	-	-	-	-	-	600	-	2,000	-	1,390	N	No apparent site available
Old Crow	65	205	-	-	-	-	-	-	-	-	650	-	3,300	-	2,260	N	Land relief - very flat - no sites available
Burwash-Destruction	50	328	Halfbreed Cr.	122	90	.44	2,600	533	17	650	500	3,400	2,500	2,600	1,740	P)	Moderately promising. Long
Destruction (only)	20	"	Bocks Cr.	183	28	.25	2,600	406	5	550	200	2,900	1,000	2,200	690	P)	penstock indicated
Teslin	95	331	Canyon Cr.	152	150	1.31	8,000	914	32	2,300	1,000	12,000	4,800	9,200	3,300	P)	Very long penstock required.
"	"	"	Strawberry Cr.	160	90	.78	3,800	685	26	1,400	"	7,600	"	5,600	"	P+)	Potential sites on Wolf Cr. and Morley R. not investigated
Johnson Crossing	10	300	-	-	-	-	-	-	-	-	100	-	500	-	350	N	No sites other than previously identified Squanga Creek apparent
Pelly Crossing	45	300	Ptarmigan Cr.	183	50	.40	7,000	560	17	860	450	4,500	2,300	3,400	1,560	P-	Long penstock indicated
Stewart Crossing	10	325	-	-	-	-	-	-	-	-	100	-	-	-	350	N	Not sufficient map detail
Watson Lake	285	420	Allen Creek	90	260	3.0	6,000	1,420	85	3,330	2,900	17,500	14,200	13,300	9,900	P-	Long Transmission. Not very promising
"	"	"	Meister River	50	700	8.2	9,000	2,290	75	6,000	"	31,600	"	24,000	"	P	Very long penstock indicated
"	"	410	Frances River	207	12,800	145	-	-	40	38,000	"	200,000	"	152,000	"	P+	Large Scale Development indicated Too large for community alone

Legend:

P = Promising
N = Not promising
Q = Annual Mean Flow
C.C. = Capital Cost
P.V. = Present Value

surplus generation for these communities and transmission back to the grid at Tagish might improve the economics of the project.

- Of the potential hydro sites in the Teslin area, Morley River and Wolf River present possibly significant environmental and social impact problems. Preliminary investigation of the site at Squanga Creek however, indicate that this would be the preferred development in the area. The environmental and social impacts of any hydro development must be carefully assessed before any project proceeds.

- All available off-peak power in Mayo is taken by the mines for space heating. To expand the load demand, however, consideration should be given to a development larger than just Mayo's needs and connection of the Mayo/Keno/Elsa system to the Whitehorse grid at Carmacks. (This would have the effect of putting Stewart Crossing and Pelly Crossing within access of the grid also.)

- Watson Lake might best be served by B.C. Hydro development of the Liard River. Originally scheduled for the late 1980's, it would now appear that hydro development has been postponed indefinitely, since B.C. Hydro forecast a large surplus of energy for many years to come.

4.2.3 Wind

Many small wind energy conversion systems "WECS" are operating throughout Canada. Nearly all of these, however, are of a 2 kW or less capacity. A 50 kW demonstration unit is presently under investigation by B.C. Hydro in British Columbia. This is the size range that might be appropriate to some remote communities. Because wind energy is not constant, it is necessary to operate in parallel with a diesel unit or other power source. The WECS acts principally as a fuel saver, and, for economic justification, is required to provide energy that is competitive with the fuel cost component of diesel generation, typically 15 cents to 20 cents per kWh. Today, a 50 kW WECS installed at a remote community and achieving a 25% annual load factor, could be expected to generate energy at 40 cents to 50 cents per kWh.

For WECS designs of more than a few kilowatts, a minimum wind speed (cut-in velocity) of around 20 km per hour is required to commence generation. Rated output is achieved at 35 to 55 km per hour depending on specific design, and for protection the equipment is stopped (cut- out) at wind speeds of 65 to 80 km per hour. Average wind speed data (provided in Section 5.0 of this report for each community) at Yukon communities indicates that average wind speeds for most are well below the feasible range for wind power generation. Only Burwash Landing and Whitehorse exhibit average wind speeds greater than 10 km per hour. A recent study by the Solar and Wind Energy Research Project (SWERP) of the Alberta Research Council, referenced by Schaeffer et al examined data on wind velocity frequencies. They reported that winds exceed 10 km per hour, 56.7% of the time at Whitehorse and 46% of the time at Burwash Landing. Since Whitehorse is already supplied by hydroelectric power, it is unlikely that wind energy will be a competitive resource for that community. Schaeffer et al (1983) calculated that a 40 kW wind generator would yield an average annual cost of about $79.00 per output GJ. The capital cost would be $180,000. BC Hydro's experience with a 50 kW unit on Vancouver Island suggests that the cost would exceed $5,000 per installed kilowatt. Transmission line costs would add further to the total.

While there may be sufficient wind resource in the southwestern Yukon area, achieving cost competitiveness with diesel generation is considered to be many years away given conservative assumptions regarding future oil prices. WECS technology and the size of units appropriate to remote communities should be technically proven in the next few years. Development progress and cost trends should be reviewed as the technology improves. This does not preclude use of small units of 2 to 5 kW output suitable for individual residences or buildings, given favourable site circumstances. The unit cost of these proven horizontal axis machines is much lower.

4.2.4 Wood Resources

Wood resources are relatively abundant at most Yukon remote communities. Wood can be used in a number of ways including the generation of steam for process heating and the cogeneration of electricity, direct heating or the firing of water tanks or water boilers for space heating and water heating, and gasification. Wood is already used across the Yukon primarily as a source of direct heat from combustion and fireplaces, wood stoves and airtight furnaces. The school at Old Crow is heated by wood. It uses approximately 200 cords per year which displaces about $22,000 in oil consumption and retains that value in the local economy annually. This money would have otherwise left the community for the purchase of fuel oil. A more sophisticated application is in use for the school at Pelly River Crossing where a wood chipper and wood fired boiler are used for space heat and hot water requirements at the school.

Approximately 130 cubic meters of chipped wood will be required by this system each year. Again, this contributes revenue directly to the community where unemployment is a persistent problem. Initial start-up problems at Pelly Crossing have been attributed to chip feed design problems resulting from architectural constraints and problems with wood chip quality. This problem may be solved by additional training and certification of chipper operators.

On the basis of data obtained from the Forest Service for this study, estimated volumes of fire killed forest areas have been determined. Firekilled areas in proximity to the study communities are indicated on the resource maps provided in Appendix A. All but a few communities have reasonable access to significant fire kill areas and wood from these regions represents the bulk of the input for wood energy presently utilized in the Yukon. The fuel obtained from these areas is relatively dense and dry (15 percent or less moisture content) and is estimated to have heat content of about 16 GJ per solid cord (2.26 m^3 or 1,000 kgs).

Schaeffer et al (1983) have estimated the annual sustainable timber harvest or allowable anual cut (AAC) at 2.2 million cubic meters per year. With an average heating value of 7.1 GJ per cubic meter, the AAC represents 15.6 million GJ of energy per year. This is more than 5 times the energy provided by fuel oils at the present time in the Yukon.

As noted above, burn areas represent a substantial supply of dry, cured wood. Many communities enjoy relatively good access to these areas. Average annual fire kill in the Yukon is about 140,000 hectares (based on 1980-81-82, from internal EMR study of Yukon Forest Biomass). Estimates of stand density for the Whitehorse fire kill area range from 82 to 102 cubic meters per hectare. Using an average of about 90 cubic meters, the annual increment of fire killed wood resources would be on the order of 12.6 million cubic meters or 89 million GJ.

The technology for using wood is relatively straight forward and well-proven. Airtight wood stoves represent the most common application and are suitable for use in most residential and smaller commercial buildings as a source of space heat. Typical efficiency of such systems is about 55%, which means about 8.8 GJ of usable energy are supplied by a solid cord. At costs of between $60 and $80 per cord, the resulting fuel cost per GJ of net energy is $6.82 to $9.09. This compares with a net cost of close to

$17 per GJ for oil with 65% furnace efficiency. While wood is much less convenient to use than oil, it is clear that the favourable economics are encouraging more and more wood use. Installed costs for wood burners range from $1,200 to $1,500 for typical residential units.

Wood use for space heating purposes is quite high in many native communities (up to 25 cords per household). More typical consumption levels are in the 4 to 5 cord range where wood is used to supplement oil heating. Wood use is very low in some sectors, often due to the fact that oil use is subsidized. This is true in Faro and in much of the Yukon and federal government housing. Wood burners can also be fitted with hot water boilers, thereby using the fuel to supply domestic hot water. Conventional water heaters are still required however, because hot water demand persists during the summer when the wood stove is not required for space heating. Wood stoves are also available which can be used for cooking.

Collection of wood is relatively unorganized and non-commercial in most Yukon communities. A typical example is the individual operator who uses a pickup truck to travel a 50 mile round trip, often hauling less than a cord.

In the Whitehorse area at least, there is some indication that efforts are being made to overcome this uneconomic situation. Recently, there has been the appearance of several operations using 5 ton trucks to deliver approximately 6 cords per haul. At least one operation exists which hauls firekilled wood by semi-trailer load from the Pelly Crossing area to Whitehorse, Dawson, Teslin, Carmacks and Burwash. Loads of 20 cords are hauled and sold for $1,000 to $2,000 depending on quality and distance hauled. Much of this wood is sold to the government for campground firewood. It also supplies local sawmills with sawlogs and some residential firewood sales.

It is probable that the utilization of wood would increase in certain areas through centralized harvesting, truck transport and forest management techniques. Certainly, some consumers would switch to wood if they did not have to obtain it themselves. There are organized wood cutting operations conducted by native bands to supply wood to seniors and band buildings. Individual supplies are generally obtained at the same time.

For larger communities, it has been shown that wood fired electrical generation is technologically feasible. Cattermole Timber in Watson Lake had planned on installing such a system, but the company is presently not operating. This system is designed to operate on wood-waste fuel from the sawmill operation.

Research into using wood for electrical generation in recent years has focussed on gasification technologies. Gasification involves the production of a gas with low to medium energy content through the burning of fuels such as wood, coal or peat under oxygen-starved conditions. The product is a gas suitable for firing in a conventional boiler or, potentially, if cleaned, an internal combustion engine and electric generator set.

Wood gasification systems involve three elements: wood handling, the gasifier itself, and gas cleanup. The wood handling system can vary from an unsophisticated front end loader approach to a sophisticated wood unloading, sizing, transport, and storage system complete with automated controls. Non-uniformity of the wood fuel product with respect to size and moisture content, and such factors as freezing, storage bin bridging and control malfunctions contribute to complications in these systems. Such facilities will require full time operator attendance and will likely be a source of high maintenance.

There are three types of wood gasifiers, classified as updraft, fluidized bed, and down draft. Each operates on the principal of incomplete combustion of hydrocarbon material and produces different gas qualities having particular advantages and disadvantages depending on the application. The fluidized bed design, so far, is the most complicated and would have to be considered inappropriate with respect to remote communities. Updraft and downdraft designs are both fairly simple in concept. The downdraft type gasifier produces a product relatively low in tar and condensibles and is the principal contender for use with modified internal combustion engines.

A gas clean up system is required to remove particulates, tar and condensibles. Particulates are removed by means of cyclone separators, while tar and condensibles are removed by washing with water, distillate oil or diesel fuel. The waste water, contaminated by hydrocarbon compounds in the water washing process, requires treatment before disposal. Both air and water pollution are concerns with respect to these technologies.

Design of suitable internal combustion engines to operate on the products from gasifier systems must also be considered to be still at an experimental or developmental stage. Fluctuations in gas quality and quantity can present serious engine performance problems. Propane or diesel fuel will be required to mix with the product gas for likely engine configurations. For the present, gasification technology must be considered too experimental for use in remote communities. The gasifier/generator demonstration project in Fort Providence, NWT has proven to require continual attention by highly qualified and motivated personnel. Dependability for these systems is certainly some years away.

An alternative technology using wood for electrical generation would involve low-pressure steam production in a conventional boiler to drive reciprocating steam engines. This is the same technology that powered river boats in the Yukon and trains across Canada until the 1940's. Such systems are much more reliable and are not technically complex. Based on their past use in the transportation sector, these systems have proven that they can be operated in remote areas, removed from highly technical support services.

The major drawback of wood-steam systems is their rather poor operational efficiency, estimated at around 15 percent. At this level, waste heat recovery would be a mandatory adjunct of the system to improve economic viability. In view of the low efficiency of a wood-steam generating system, an appropriate way of looking at it would be to find a space heat load and view the electric generation as a by-product of the space heating. Further study of the economics of such a system should be carried out before a demonstration project is contemplated.

With any wood based electrical generation or large scale heating system, whether a gasifier or steam operation, much of the investment will be in the wood supply part of the operation. Wood preparation equipment is required to reduce supplies to usable form, ie. logs, chips or small blocks. It should be noted that while wood gasifiers require chipped wood, small steam systems could use round wood. Experience in the N.W.T. has shown that the most effective method to supply fuel to a wood burning plant is to engage independent contractors to deliver roundwood to the generator site.

An important factor in favour of wood based technologies, is the fact that the harvesting and use of wood resources keeps economic resources within the Yukon and provides local employment. The same comments can be made in favour of using locally produced coal. With oil purchases, all except some of the distribution revenue goes out of the territory.

4.2.5 Coal

The technology for coal fired electrical generation or steam production is fairly sophisticated and expensive, and reserved for large scale plants. For remote communities, its practical application is for direct heating using controlled air stoves. Though not so convenient a fuel source as oil, this type of use is considered to be practical for heating small buildings. The principal issue is its availability at an acceptable cost, and, to a lesser extent, the acceptability of stack emissions. For space heating, coal could be used as a dual fuel in specially designed airtight stoves.

At the present time there is no household distribution network for coal in the Yukon.

Compared to oil, the industrial scale use of coal, either to generate electricity or steam for process heating, presents a number of special problems. Its bulk and irregular size, requires physically large and expensive facilities to crush, transport, store, reclaim and prepare for final firing. Compared to oil fired units, boiler volume requirements are significantly larger and the boiler design more expensive for a given heat release. Ash removal and its final disposal requires constant management of ash storage to avoid ground water contamination from leachate action. The control of boiler emissions (ie. particulates, sulphur dioxide and nitrogen oxides) also requires special attention and significant cost is involved in meeting environmental emission limits.

Coal is apparently being used presently on an experimental basis by a motel in Whitehorse for space heating purposes. With the commencement of operations at Whitehorse Coal, it may be possible that coal suitable for use by relatively large buildings will be available in the future. However, at a price of $150 per ton and an assumed energy content of about 12,000 kilojoules per kilogram, the economics of such utilization could be marginal. Combustion efficiencies for space heating applications would be expected to be about 65%, and at this price level, coal is slightly more expensive than oil for space heat use.

4.2.6 Solar

An assessment of the practicability for using solar energy requires a blend of idealogical concepts and hard economic facts. Many experimental and related economic studies have been made to determine the feasibility of various applications of solar energy. The results of these appear to indicate that solar energy may have limited application in the case of remote communities. The most common solar energy systems are those used for space heating of buildings and for hot water heating. Solar energy can also be converted directly to electrical energy by photovoltaic cells; however, this application has not found widespread use for most practical purposes. The foregoing comments refer primarily to active solar systems.

Active systems may have an application for large hot water heating requirements, especially where these requirements coincide with the summer as is the case with swimming pools or laundromats/shower facilities in tourist oriented areas. Greenhouse applications have also been found to be quite suitable in the Yukon. These have the benefit of providing homegrown vegetables while at the same time serving as large heat collectors, even during late winter months.

Virtually every building and every community in the Yukon could benefit from oil reductions achieved by increased application of passive solar.

In passive heating systems, building modifications are made and insulation levels increased in order to capture as much solar energy as possible while at the same time minimizing heat losses. Building modifications would consist of increasing window areas on southern exposures and reducing the areas on northern exposures. Windows should also be fitted with night insulation consisting of insulated shutters or sliding doors which can be closed over the windows at night.

The cost of retrofitting these modifications to existing buildings can be substantial and must be determined on a building specific basis. Nevertheless, it is certain that some gains can be obtained in a large number of existing buildings. For new construction, the cost of incorporating passive solar features can be quite minimal if the designer is conscious of the advantages from the beginning. Certainly for any buildings to be constructed in the future in the Yukon, every effort should be made to orient the building such that the bulk of its glass surface area faces south.

In view of the conflicts that can arise with competition for access to sunshine and the usable energy that can be gained, every effort should be made to ensure that future subdivisions and lots be sited for good solar potential. An ideal situation would be a gentle south facing slope and streets running east-west.

A back-up space heating system must be included in buildings using passive solar energy for periods when sufficient solar is not available. The efficient use of passive solar also requires high levels of insulation to minimize heat losses. A degree of energy awareness is required to insure that night insulation, if used, is installed and removed each day as required.

4.2.7 Biogas Generation

Biogas is generated from the anaerobic fermentation of organic wastes. The gas produced contains about 60-75% methane, with the remaining portion of the gas comprising mostly carbon dioxide and traces of other gasses such as hydrogen and hydrogen sulphide. As an energy source, biogas has a heating value of 20-26 megajoules/M3. This compares to 33-40 megajoules/M3 for methane and 39-81 megajoules/M3 for natural gas.

Anaerobic digesters have been used for many decades throughout the world to treat organic wastes. The size of the units vary from small, single farm or family units to large systems that are an integral part of sewage treatment plants serving major cities. The City of Calgary uses a large methane digester to treat sewage. In the larger plants the biogas generated from the process is usually used to heat the treatment plant facility. In Asia many thousands of the smaller units often called "Gobar Plants" are used successfully for small individual farming operations and communities where the gas produced provides energy for heating and cooking.

The conventional methods of anaerobic digestion involve the addition of an organic waste slurry into an airtight containment vessel called the digester. Usually the digester is heated and a mixing device is added, both of these improve the efficiency of the process. Complete digestion usually takes 20-40 days. The resultant residue is rich in nutrients and an excellent fertilizer. Since this process significantly reduces pathogenic organisms the residue is considered safe for disposal to the environment.

Biogas production is considered optimal at approximately 35 degrees C although the digestion process will occur in the range of 10 degrees C to 70 degrees C. The efficiency of the system and subsequent gas production drops markedly with lower operating temperatures. The practical lower temperature limit for gas production is considered to be about 15 degrees C. The amount of methane that can be produced from human sewage waste is 0.02-0.03 M3 per person per day. For a community such as Whitehorse with a population of 15,000 persons, this could result in the production of 300-450 M3 of gas per day of the potential heating value of about 11,000 - 16,000 magajoules/day. This equates to .7 - 1 megajoule per person per day.

Some of the advantages of anaerobic treatment of sewage wastes are:

- low production of biological solids reducing disposal problems;
- high degree of waste stabilization and efficiency in reducing COD to 85% of the input;
- production of methane gas (valuable energy);
- low capital and operating costs for continuous flow digesters with low retention times;
- accepts feedstocks with low nutrient concentrations.

Disadvantages and consideration, particularly for northern applications include:

- high optimum operating temperature (35 degrees C) may limit economically attractive treatment installations to warmer waste waters (i.e. 25 degree C or more) or to a system incorporating an external heat source;
- slow growth rate of methane bacteria at low temperatures necessitates longer biomass retention times;
- microorganisms responsible for anaerobic fermentation are sensitive to PH, organic loading rates, temperatures and toxic substances.

In the past few years, with the emphasis on economic, environmental, and energy considerations, there has been an increase in research involving anaerobic treatment technologies. The world-wide interest over the past decade has led to the development of high-rate anaerobic digestion processes. These processes are based on much higher microorganism to waste contact efficiency and biomass retention. With these systems waste stabilization and treatment can be obtained with retention times as low as 12 to 24 hours, as compared with 30 days with the conventional batch digesters. Some of these advanced anaerobic reactors include the anaerobic filter, upflow sludge bed reactor, fluidized and expanded bed reactor, down flow stationary fixed film reactor and the anaerobic contact process. High rate processes have yet to attain widespread use. However, several full-scale high rate anaerobic systems are now being marketed and these installations are now operating satisfactorily to treat a variety of organic wastes. Recent studies have shown that such a process may be suitable for northern applications involving treatment of moderately concentrated wastes such as pumpout sewage, sewage bag wastes, or combinations thereof.

One major consideration for the use of anaerobic digestion facilities in the north is the cold climate. Unless an external heat source is available to maintain digester temperatures for efficient operation, a major portion of the biogas production would probably be used just to heat the facility. Considering the efficiency of treatment afforded by the recent high-rate systems, the useful byproducts, biogas and fertilizer, and the comparatively inexpensive operational costs, it is possible that anaerobic digestion may be an alternative for some northern applications. A study is presently in progress to examine the technical, economic and social feasibility of operating an anaerobic treatment facility for the village of Old Crow, Yukon. The overall study will investigate the feasibility of recovering waste heat from a diesel-electric generation plant. The recovered heat will be used to maintain the necessary heated environment to produce vegetable and poultry products. Integrated within this facility would be an anaerobic digester using waste heat to operate and produce biogas and fertilizer as well as provide for the disposal and treatment of poultry waste, vegetable waste, and domestic sewage.

Certain factors must be carefully examined before seriously considering anaerobic digestion and methane production facilities for the north. These include the characteristics of the sewage (i.e. concentration, constituents, temperature, etc.), present and future sewage handling and disposal methods, volumes of sewage and other feedstock available, location of facility, climate, availability of external heat sources, operation and maintenance, capital costs, and of major importance, the social considerations (i.e. public acceptance, involvement and support).

Given the proper set of circumstances, anaerobic digestion may be an excellent alternative to conventional lagoon type sewage treatment. On the basis of energy production alone, Whitehorse may be the only center in the Yukon with a large enough supply of organic wastes to supply an economically feasible methane facility. However, the ability to solve problems associated with conventional sewage treatment systems may make it an appropriate choice in many other Yukon communities where the present treatment facilities are inadequate in terms of both sewage collection and effluent disposal. The available biogas, like the nutrient rich sludge would be considered as a valuable byproduct of a necessary municipal service.

4.2.8 Geothermal Energy

Geothermal hotsprings at temperatures of 50° C and above provide a potential source of hot water for meeting community hot water and space heating needs. The technology is simple and straightforward, comprising pumps, heat exchangers and insulated pipe work systems. The principal requirements affecting the economic potential for this resource are adequate resource temperature; proximity of hotspring and accessible terrain conditions between hotspring and community; requirement for a community hot water distribution system and high annual demand for heat.

All the geothermal resources thus far identified in the Yukon, are relatively low temperature water supplies (</100°C). Temperatures in excess of 180° C. are generally considered necessary to generate electricity from geothermal resources. Electricity generation is not likely to be feasible in the Yukon given the present state of the data base and the lack of any known major geothermal sources near Yukon communities.

A recent study by Schaeffer and Associates has indicated that near surface low temperature geothermal sources may be available in some locales, especially around Haines Junction, Whitehorse, and Mayo. Costs of development and resulting energy costs are entirely site dependent preventing any useful generalization vis a vis competitiveness with oil or other forms of heating.

The city of Whitehorse has been looking at opportunities to utilize the warm water aquifer underlying the Riverdale area of the City. The most likely use of this resource in the future would be through application of groundwater heat pumps. The technology for these is discussed in the next section.

Another interesting development relating to the geothermal source of energy, is in the possibility of forced extraction of heat from underground rocks. Within the next three years scientists and engineers hope to be able to confirm whether the possibility of forcing water from the surface, through underground rock formations that contain natural heat, is economically feasible, and so provide a major new source of energy.

Research conducted in Cornwall, England shows that the principle is technically feasible. Cold water pumped into 300 m boreholes has been extracted at 11°C. 2000 m holes have located rock temperatures of approximately 80°C, through which water temperatures have been raised to 30°C. The technique is to pump cold water down the borehole and force it through fractures artifically created in the dry rock formation to a second borehole, the water absorbing heat along the way.

Such a system could be used for freeze protection, or even space heating. If hotter rocks can be located, it could be possible to extract water at around boiling point so that the heat could be used to drive turbines for generating electricity.

4.2.9 Heat Pumps

The heat pump operates on refrigeration principles, removing energy from a low temperature source and discharging it at a higher temperature. High grade energy (electricity or mechanical work) is supplied to the process to maintain this flow of energy. The quality of high grade energy needed increases with the temperature difference required. For space heating applications, the heat energy delivered is in the range of 3 to 5 times the electrical energy input. If this electrical energy is supplied from a relatively low cost source, the heat pump economics can be very attractive.

However, where electrical energy supplied is generated from the combustion of fuel (ie. diesel generation) the efficiency losses negate the gains achieved from the heat pump. In general, the economics of heat pump operation do not compare favourably with other forms of heating unless a low cost source of electricity is available.

Packaged heat pump equipment suitable for individual residences is available. The system requires a source of low grade heat. A large water body is the ideal medium. The atmosphere can be used but both heat pump capacity and efficiency decrease at a time when heating requirements increase, during the winter. In addition, the frosting of air coils can be a problem.

4.2.10 Waste Oil Recovery

Statistics Canada records indicate that approximately 1.6 million liters of lube oils and greases are sold in the Yukon annually. It is estimated that close to 1 million of these are recoverable and suitable for displacement of fuel oils. (Some products are not generally useful such as various solvents, antifreeze, some hydraulic fluids and highly viscous greases.

Most of this waste oil is probably being buried or dumped at a community disposal site at present. If a collection and storage system were in place, however, the recovered oil could be applied to a number of uses including:

- supplementing diesel fuel on electric generators;
- space heating in either specially designed waste oil furnaces or mixed with fuel oil for conventional furnaces;

- road oiling.

In most small communities in Alaska, the largest single source of waste oil is the diesel generating plant. Environmental Services Limited (1982) has estimated that up to 90% of the waste oil is produced by the diesels in remote Alaskan communities. In the Yukon, additional major sources of waste oil are highways department garages and the mines.

The advantage of using the power plant's waste oil for electric generation is that a community-wide waste oil management program is not required. To use this oil, however, special filtering and mixing mechanisms must be installed at the diesel plant. Nevertheless, the economics can be quite favourable for such systems. In British Columbia, the Ministry of Transportation and Highways is experimenting with the recovery and use of waste oil at remote highway grader stations and maintenance camps. Results of these efforts are not yet available.

Wide scale waste oil recovery programs raise a number of environmental and safety concerns since it is difficult to protect against contamination of the wastes by harmful substances such as PCB's, dissolved metals and acids. Risks of spills during transportation and transfer operations would also be a concern.

4.2.11 Peat

The extent and quality of peat lands in the Yukon is presently poorly documented, but large areas are known to exist in the Old Crow area, on the North Slope and around Dawson. Unfortunately, much of this peat is in continuous permafrost areas which makes drainage and drying of the peat quite difficult. Also, the development of a peat bog can take several years of preparation due to the slow process of removing moisture through drainage.

Even "dry" peat has a relatively high moisture content of between 40 and 50 percent. This results in rather low combustion efficiency in home furnaces (approximately 20 percent). The energy content of peat is comparable to that of wood, but the low conversion efficiency can make its use much more expensive than wood.

As long as fuel wood is available in Old Crow and Dawson, it is unlikely that peat will constitute a significant energy supply alternative.

5.0 COMMUNITY ENERGY PROFILES

5.0 COMMUNITY ENERGY PROFILES

5.1 INTRODUCTION

Twenty-two communities in the Yukon have been identified by ENERGY, MINES & RESOURCES for consideration in this study for which information is required at a desk study overview level only. The communities concerned each exhibit very individual characteristics. However, from an energy perspective at the level required, it is convenient to deal with them in three basic groups.

Residential building statistics, derived from Statistics Canada data, have been analyzed and tabulated for the communities with 1981 populations greater than 250. These are shown in the following two tables.

Two of the groups are categorized according to the primary influence supporting their existence, while the remainder are identified by location. The three groups with brief explanatory notes are as follows:

- Urban Centers

These communities share features not found in any of the smaller communities, due to their size and role in the Yukon network.

- Mining Communities

In these communities the main consideration is the special energy needs normally associated with mining development and the common influences (market, exploration), etc. thereby exerted on these communities. Coincidentally, their location corresponds to a geographic area.

- Other Communities

These communities are listed in alphabetic order in the sections following Urban and Mining communities.

For each community, a series of tables is provided which highlight cultural and economic features of the individual communities. The community background profiles cover general geographic indicators, population and housing, community facilities and services and infrastructure.

5.1.1. Community Energy Profile Methodology

The community energy profile tables which follow the background discussion of each community, summarize community energy use for an average year based upon 1950-1980

TABLE 5-1

YUKON RESIDENTIAL BUILDING STATISTICS
SOURCE: Statistics Canada 1981 Census

	WHITEHORSE	%	FARO	%	DAWSON	%	WATSON LK	%	MAYO	%	HAINES JT	%
Population	14914	64	1652	7	697	3	748	3	398	2	366	2
Occupied Prvt Dwelgs	4980	66	455	6	245	3	245	3	135	2	120	2
single detached	2675	54	110	24	170	69	130	53	100	74	85	71
double house	440	9	40	9	5	2	5	2	5	4	0	0
row house	255	5	160	35	0	0	0	0	0	0	0	0
duplex	100	2	20	4	10	4	5	2	10	7	0	0
apartment	855	17	45	10	25	10	30	12	5	4	10	8
attached to non-res	20	0	0	0	5	2	5	2	5	4	5	4
movable	635	13	75	16	35	14	75	31	15	11	20	17
Period of Constructn												
pre 1920	40	1	5	1	55	22	0	0	0	0	0	0
1921-1945	245	5	0	0	20	8	5	2	15	11	5	4
1946-1960	970	19	5	1	15	6	30	12	35	26	20	17
1961-1970	1205	24	195	43	40	16	45	18	20	15	20	17
1971-1975	1110	22	145	32	50	20	95	39	45	33	40	33
1976-1979	1195	24	65	14	45	18	65	27	20	15	35	29
1980	190	4	45	10	10	4	5	2	5	4	10	8
1981	30	1	0	0	0	0	0	0	0	0	0	0
Principal Htg Fuel												
Oil or Kerosene	3280	66	430	95	190	78	205	84	90	67	100	83
Propane	90	2	5	1	5	2	10	4	0	0	5	4
Electricity	1140	23	10	2	10	4	15	6	15	11	5	4
Other	480	10	5	1	45	18	15	6	25	19	15	13
Primary Htg System												
Hot Air	2630	53	385	85	130	53	180	73	90	67	95	79
Steam or Hot Water	780	16	50	11	25	10	25	10	0	0	10	8
Installed Electric	1070	21	10	2	10	4	10	4	15	11	5	4
Stove	305	6	5	1	65	27	15	6	25	19	5	4
Other	185	4	5	1	10	4	15	6	0	0	5	4
Water Htg DHW Fuel												
Oil or Kerosene	840	17	35	8	35	14	40	16	0	0	10	8
Propane	140	3	5	1	15	6	35	14	0	0	10	8
Electricity	3870	78	415	91	170	69	170	69	130	96	95	79
Other	130	3	5	1	25	10	5	2	5	4	0	0
Number of Rooms												
1-2	325	7	5	1	25	10	10	4	15	11	5	4
3-4	1320	27	55	12	65	27	55	22	40	30	30	25
5-6	1680	34	280	62	110	45	125	51	60	44	70	58
7-9	1380	28	110	24	35	14	45	18	10	7	20	17
>10	275	6	5	1	5	2	5	2	0	0	0	0
average	5.7		5.8		4.8		5.5		4.6		5.3	
# with bathroom	4835	97	455	100	220	90	240	98	120	89	115	96

TABLE 5-1

TESLIN	%	CARMACKS	%	Otr YUKON	%	TOTAL YUKON				
310	1	256	1	3912	17	23153				Population
90	1	75	1	1240	16	7585				Occupied Prvt Dwelgs
80	89	55	73	1040	84	4445	59			single detached
0	0	0	0	10	1	505	7			double house
0	0	0	0	5	0	420	6			row house
0	0	0	0	5	0	150	2			duplex
0	0	0	0	20	2	990	13			apartment
0	0	5	7	10	1	55	1			attached to non-res
10	11	20	27	150	12	1035	14			movable
										Period of Constructn
0	0	0	0	50	4	150	2			pre 1920
5	6	5	7	55	4	355	5			1921-1945
10	11	10	13	190	15	1285	17			1946-1960
30	33	15	20	315	25	1885	25			1961-1970
25	28	30	40	295	24	1835	24			1971-1975
10	11	15	20	255	21	1705	22			1976-1979
0	0	5	7	70	6	340	4			1980
5	6	5	7	15	1	55	1			1981
								GJ		Principal Htg Fuel
40	44	50	67	450	36	4835	64	725250		Oil or Kerosene
0	0	0	0	20	2	135	2	20250		Propane
0	0	0	0	75	6	1270	17	190500		Electricity
50	56	35	47	690	56	1360	18	204000		Other
								total GJ=	1140000	
										Primary Htg System
35	39	50	67	370	30	3965	52			Hot Air
5	6	0	0	100	8	995	13			Steam or Hot Water
5	6	0	0	40	3	1165	15			Installed Electric
50	56	25	33	490	40	985	13			Stove
0	0	5	7	245	20	470	6			Other
								GJ		Water Htg DHW Fuel
5	6	0	0	65	5	1030	14	20600		Oil or Kerosene
5	6	5	7	115	9	330	4	6600		Propane
45	50	55	73	585	47	5535	73	110700		Electricity
40	44	20	27	475	38	705	9	14100		Other
								total GJ=	152000	
										Number of Rooms
15	17	10	13	260	21	670	9			1-2
30	33	20	27	435	35	2050	27			3-4
40	44	45	60	395	32	2805	37			5-6
10	11	5	7	135	11	1750	23			7-9
0	0	0	0	20	2	310	4			>10
4.5		4.6		4.3		5.01				average
55	61	47	62	780	63	6867	91			# with bathroom

normal degree days as published by AES, and electrical consumption from 1980 and 1981 to indicate "business as usual" conditions in the Yukon.

The methodology for data collection and analysis used in this study is consistent with the CMHC publication "Community Energy Audit Guidelines". The incomplete nature of the data base has necessitated the use of both "top-down" and "bottom-up" modelling procedures. In the top-down methodology, total energy use is disaggregated into its component parts, whereas in the bottom-up methodology, total energy use is aggregated from the component parts. Where possible, the bottom-up approach was undertaken by gathering historic energy use data from the consumer level. The top-down approach was used to fill in gaps in the available data.

Total energy use in the form of electricity and space heating fuel has been compiled by use sector. The communities have been divided into the following sectors; Federal Government, Territorial and Municipal Governments, Education, Commercial, Federal Government residential, Yukon Housing Corporation dwellings, privately owned residences primarily heated by oil, and privately owned dwellings heated totally with wood. For Whitehorse, Statistics Canada reports that 23 percent of the dwellings are electrically heated; this sector is included with the energy profile for Whitehorse. Many of these houses are significantly heated with wood.

In the case of mining communities, fuel and electricity use for the mines is tabulated as the Industrial sector. For each community, per capita energy use as total gigajoules per person per annum has been computed from aggregated energy use and 1981 Statistics Canada data. In those cases where electricity is generated from fuel oil, a total gigajoules input per capita is computed.

For electricity consumption, community specific tabulations of energy sales were obtained from YECL and NCPC. Total sales and numbers of customers in each sector were used to determine average customer consumption. Total electricity consumption for each community was validated through comparisons with YECL and NCPC records. In the case of schools, average electricity consumption was computed from 1980-83 YTG Education records.

For fuel consumption, community specific data were obtained for Federal and Territorial government fuel requirements estimates for 1978-84. These estimates have been disaggregated on the basis of consumption records for specific buildings where data are available. Commercial sector fuel consumption data are not available in most cases for communities outside of Whitehorse. On the basis of data obtained from a sample of Whitehorse commercial buildings which could be considered typical in other communities, a ratio of electric energy to fuel energy was developed. This ratio is used to estimate the fuel energy requirements for commercial buildings where little specific data exist.

For each community, data from Yukon Housing Corporation, EMR Residential Energy Surveys, RCMP housing data and Government of Canada Heating Assistance payments applicants, were used to compute fuel energy consumption for an average residential building. The residential averages are then combined with housing statistics to aggregate residential sector consumption.

The energy profiles thus produced indicate consumption levels with wood and petroleum based heating. Where wood is the primary source of heat, energy consumption estimates are generally higher due to the conversion efficiencies associated with wood burning. The Total Gigajoules figure calculated for each community indicates the gross input of energy which can be addressed through energy conservation and fuel substitution.

The retrofit potential index (RPI) was developed by Arctech as a means of identifying buildings with the greatest payback potential for energy conserving retrofit measures.

The RPI for an individual building is computed as the building energy efficiency (MJ/M3/DD) times the gigajoules of energy consumed during an average year. As an example, a building with an average efficiency of 0.04 MJ/M3/DD (40 KJ/M3/DD), which used an average of 150 Gigajoules of energy for space heating, would have an RPI of 6. The higher the RPI, the greater the potential for cost-effective energy conservation measures.

Use of the RPI prior to conducting detailed energy audits of buildings in a community will provide an organizational framework for subsequent audits and retrofit evaluations. The RPI provides a valuable tool for economical community energy planning development.

5.1.2 Recommended Alternatives - General Comments

The final portion of the community discussions addresses possible off-oil alternatives for each.

Without exception, the most cost effective and technically proven means for reducing oil consumption in every Yukon community will be through conservation. The previously noted figure of over $3 million in savings for the residential sector alone is probably quite conservative. In addition, the commercial and government sectors could probably realize at least as much oil displacement. It should also be stressed that such savings would immediately result in more disposable income in the Yukon and employment in the building trades and supplier ranks.

Methods for utilizing alternative resources to displace oil consumption are invariably going to be more expensive than conservation. Before any alternative is developed, detailed examination of the associated costs and benefits must be carried out based on net requirements after conservation. It is the intent of the federal government to reduce dependence on oil but not at all costs. The return, in terms of the economic benefits to society associated with displacement of an imported, scarce and non-renewable resource is almost certainly geater than the current market value of the product, however. It is these considerations which will determine the ultimate attractiveness of any alternative.

The following general comments on specific oil reduction or displacement technologies apply to all communities where such alternatives are suggested.

(a) Wood Collection: One of the impediments to greater wood usage is the lack of a well organized, integrated, commercial wood supply system. Many potential users of wood are deterred by the effort required in falling, cutting, hauling, storing and splitting for themselves. A centralized wood supply operation would almost certainly be more economic than individuals travelling up to 100 km in their own pick-up trucks to get less than a cord of wood.

A "utility company" approach to wood supply will be a prerequisite for any large scale wood heating systems, electrical generation from wood, or significant penetration of government or commercial sectors.

(b) Wood Stoves and Furnaces: Better dissemination of consumer information, the promotion of more efficient wood burners, and improved fire management techniques by the user are required to make wood heating more attractive. Many of the wood burners presently in use in the Yukon are relatively new and it is unlikely they will be replaced by newer models in the near future. A possible alternative for these is the retrofit of stack catalytic combustors which reduce creose build-up and pollution problems as well as improve efficiency.

(c) Wood/Coal Fired Electrical Generation: High pressure steam, thermal coal generating plants are not economic at the scale required for small communities. Gasification technology is unproven and indications are that it is too technically demanding for remote communities. Low pressure steam engines are simple, proven technology, but have not been demonstrated at feasible electric generation schemes for remote communities. More research on the economics of such systems is required before they can be recommended.

(d) Heat Pumps: Heat pumps can only be considered in communities where there is relatively inexpensive hydroelectric power available and where a body of water can be accessed. Installation costs will be greatly improved if the water is close and relatively warm. Heat pumps operating on air rather than water are likely to be unsatisfactory in the cold winter temperatures of the Yukon. Heat pump units are fairly sophisticated and parts and maintenance could present difficulties.

(e) Waste Heat Recovery: Wherever diesel generators are likely to remain, waste heat recovery should be a high priority. Widespread district heating systems are generally uneconomic, but every effort should be made to distribute heat to schools, other large institutional or commercial buildings, or multiple dwellings. The economics are further improved if the candidate buildings already have hydronic heating systems. In some communities, it may be appropriate to move the diesel sets to locate them nearer the major heat demand buildings.

(f) Hydro Developments: Small hydro projects will only be economic for individual communities if they are implemented as "total energy" systems. That is, they should be considered in terms of handling all electrical and thermal energy requirements including space heating, DHW heating, lights and appliances. Such systems will not be economic if they are viewed only as replacements for the diesels.

Site specific studies are required to determine the economic, environmental, social and technical viability of any hydro scheme.

(g) Hydro Capacity on the Grid: Uncertainty persists with respect to the availability of hydro generating capacity on the Aihishik/Whitehorse/Faro system. At the present time, installed capacity exceeds demand. Under such circumstances, the appropriate oil conserving response would be to encourage as many oil users as possible to convert to electrical heating. However, if Cyprus Anvil commmences operations in the near future, the capital costs of these conversions will be wasted unless more generating capacity is put on the grid. This dilemna requires much more detailed investigation to determine the appropriate policies to be adopted.

(h) Propane: Propane can be a suitable substitute for oil in all communities. The price of propane, however, must be brought into line with its energy value relative to oil, either through incentives or appropriate pricing policies. Propane can be used for space heating, cooking, hot water heating and other purposes. The economics of propane vapour distribution systems should be addressed if the pricing issue can be settled satisfactorily.

The final section of each community discussion provides a review of potential alternatives for each community aside from conservation. These alternatives are presented in general order of their overall potential for helping the community to reduce oil consumption.

The options presented are based on the availability of suitable resources, the technical maturity of the technology and the potential for the alternative, to meet the demands of the community. Appendix A, at the end of this section, provides a series of base maps to be used as a reference to the discussion of alternatives.

5.2 URBAN CENTERS

The three communities designated urban centers have relatively high concentrations of population and government services, and act as service centres for their surrounding regions.

For the purposes of this study, Whitehorse, Watson Lake and Dawson City are grouped as urban centers.

5.2.1 Whitehorse

5.2.1.1 Cultural and Economic Setting

Accessibility was a key factor in the settlement of Whitehorse. It served as a stopping point for people en route to the Klondike. By 1900 the White Pass and Yukon Railroad serviced the settlement and there were 2,000 inhabitants. Whitehorse survived a shortlived copper boom in the 1920's, but the real impetus to securing the importance of Whitehorse was the building of the airport in 1939 and the subsequent construction of the Alaska Highway. This was reinforced by the Canol Pipeline and road and the building of an oil refinery. In 1951, when government services moved from Dawson City to Whitehorse, Whitehorse again became the center for mining and prospecting. In 1953 it became the capital city of the Yukon. It is now the transportation, communication and distribution center of the Territory. Sixty-five percent of the Yukon population lives in the Metro area of Whitehorse, which includes Downtown Whitehorse, Marwell Industrial area, the Kwanlin Dun Village, Riverdale, Hillcrest, Valleyview, Takhini, and the Alaska Highway subdivisions of McRae, Porter Creek, Wolf Creek, McPherson and Crestview.

5.2.1.2 Community Energy Planning for Whitehorse

If the community of Whitehorse wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Whitehorse.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Whitehorse, then the estimated space heating load of 1674000 Gigajoules could be reduced by 50 percent to 837000 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Whitehorse, the other sector which uses a large proportional amount of energy for space heating is the Federal Government sector. Federal Government buildings consume 5 percent of the space heating fuel and comprise only 1 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public

TABLE 5-2

COMMUNITY ENERGY PROFILE: WHITEHORSE POPULATION: 15000

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL SPHT GJ	%	TOTAL GJ	%
FED GOVERNMENT	61	1	120	7320	5	1230	75000	5	101331	5
YUKON & MUNICPL GOVT	45	1	120	5400	4	800	36000	2	55424	3
EDUCATION	13	0	308	4000	3	5385	70000	5	84388	4
COMMERCIAL	1225	18	40	48880	35	561	692835	45	868662	43
FED GOVT RESIDENTIAL	207	3	14	2898	2	170	35190	2	45614	2
YUKON HSG CORP	60	1	14	840	1	134	8040	1	11062	1
RESIDENTIAL (elec)	1242	18	18	22356	16				80427	4
RESIDENTIAL	3351	50	12	41602	30	155	519405	34	669053	33
RESIDENTIAL (ttl wd)	540	8	12	6704	5	168	90720	6	114835	6
TOTAL	6754			140000			1527190		2030787	
TOTAL RESIDENTIAL	5400			74400						

GJ USED PERCAPITA 135

kWh/litre gen eff: GRID 0 GJ

TOTAL GJ INPUT: 2030787

GJ INPUT PERCAPITA 135

buildings will offer the most favorable conservation/ retrofit opportunities.

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementation of energy conservation. People from communities throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to energy conservation. Beginning in 1984, Yukon College, through the Education Extension Program will offer courses in Whitehorse for those who are interest in retrofit technology, energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved. This will result in reductions of oil use, both through direct space heating and energy requirements for fuel transport. Residential buildings sampled in Whitehorse for this study, indicate retrofit potential indices (RPI) as high as 27. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in Whitehorse and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load ranges from 132 to 168 Gigajoules per household. The lower figure undoubtably reflects seasonal occupation of the houses and/or the utilization of wood as a supplementary heating fuel. The upper figure represents totally wood heated households. Three factors contribute to this high value. Firstly, the typical inefficiency of most wood burning appliances, secondly, the inaccuracy of estimated "cord" value, and thirdly, the residences which use wood as the primary heating source are generally less thermally efficient than other residences in the community.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

Since Whitehorse is connected to the hydroelectric power grid, electricity is an available renewable resource which could be used for space heating. However, since electricity supplies higher grade energy requirements which cannot be feasibly provided by fuel, then it may be more prudent to utilize electricity to sustain the desired level of economic development, than to use it as an alternative source for space heating. Only those buildings which meet the recommendations for the upcoming Northern Building Energy Standards (NRC-DBR) can be considered as viable candidates for electrical space heating.

Another renewable energy supply option which would be more favorable than hydro-electric power for space heating in Whitehorse is the efficient utilization of wood as a space heating fuel, and a well organized fuel wood delivery system.

Other energy supply options for Whitehorse are discussed in the following sections.

5.2.1.3 Energy Supply Alternatives

(a) Hydro

A key concern in any consideration of Whitehorse is the disposition of the current surplus of hydroelectrical energy. If this surplus is expected to persist for some reasonable length of time, then the most efficient use of it would be to encourage, primarily through the pricing system, greater use of electricity for end-uses that presently consume a lot of oil. Large commercial and institutional users could probably take greatest advantage of this situation by converting their space heating systems. Depending on the magnitude of the surplus, however, it might even be appropriate for individual householders to install electric element heating provided oil is displaced rather than wood. Even at current market prices for oil and electricity, the cost per usable GJ is quite comparable depending on the conversion efficiency for oil consumption. Refer to the general comments in Section 5.1.2 on this subject.

(b) Wood

Wood is the next best resource for Whitehorse. Probably the best application is in the direct heating of residential space. Since the average household consumes over 3,000 liters of oil per year and about 75% of this is for space heating, much of which could be displaced by wood. Estimates for the life of the supply of wood from the fire-kill area north of Whitehorse alone range from 37 years to 80 years based on existing use estimates.

Wood use is minimal in the commercial and government sectors. If an organized and economic supply were assured, it is certainly feasible to use wood for space heating in many of these buildings, some of which are very intense users of oil.

Air pollution from wood burning has already been noted as a problem in Riverdale. This occurs partially due to the nature of the air basin in that area and partially due to poor fire management techniques by users. See the general comments on wood usage in Section 5.1.2.

(c) Coal

Coal is another resource available to Whitehorse. The most likely prospect for large scale coal production is at the Whitehorse Coal property southwest of town. Before this venture could be launched on a commercial scale however, significant markets must be assured. This probably means the Yukon mining operations as well as some offshore sales. Nevertheless, if the development of the property goes ahead, reasonably priced coal could be available in Whitehorse.

The coal is reported to be of a relatively high energy content, containing less than 1.0 percent sulphur. For residential space heating, coal could be burned in wood burners. For larger buildings with hydronic heating systems, coal fired boilers would be appropriate. The central heating system operated by the federal government at Takhini could be a possible demonstration site for a coal fired system. Coal fired electric generation is discussed in the general comments in Section 5.1.2.

(d) Geothermal/Heat Pumps

Warm groundwater is already used in Whitehorse to protect the water system from freezing. The aquifer underlying Riverdale is reported as having a year round temperature of 10° - 14° C, but this is not very useful for any direct application other than freeze protection.

If combined with heat pump technology, however, there may be some potential. The availability of a body of warm water means that the volume of fluid supplied to the heat pump can be much less than if river or lake water at about 0°C were used. If the aquifer is sufficiently shallow, the economics for its use may be quite favorable as long as relatively cheap, hydroelectric power is available to run the pump.

Heat pumps are available in a wide range of sizes and could be used even by individual householders. Larger buildings, howeve, would be more efficient applications, especially if they already have a hydronic heating system. See the general comments on heat pumps.

5.2.1.4 Energy Use Data tables for Whitehorse

TABLE 5-3a

YTG & MUNICIPAL BUILDINGS ENERGY USE: WHITEHORSE - Education
SOURCE: YTG Energy Branch, YTG Supply Services Branch, YECL

#	DESCRIPTION	83-4 FUEL EST LTR*1000	82-3 ELEC MWH	82-3 FUEL LITRES	81-2 ELEC MWH	81-2 FUEL GAL	80-1 ELEC MWH	80-1 FUEL GAL
206	Takhini Elem	3	100	24690	126	7304	164	5651
254	Takhini Mobl		6	2687	8	690	8	593
207	Whitehorse Elem	128	227	140618	210	28835	226	22950
208	Selkirk Elem	200	339	146239	469	40147	470	39870
220	St. Elias Dorm	9	37	17175	40	2446	32	1915
221	F.H.Collins High	447	1195	477373	1246	97561	1342	96731
222	Yukon College	195	506	223468	583	66736		53971
222B	YC Annex2 Nisut	22	49	14504				
225	ChristKing Elem	113	88	49383	110	16228	90	12879
226	ChristKing High	113	110	116908	180	23514	167	22632
233	Jk Hulland Elem	196	514	182809	737	44230	565	41726
258	Jeckell Jr High	200	498	250657	474	57613	564	44575
281	Grey Mtn Primary	12	120	25682	98	4058	144	12041
282	Ptr Ck Jr High	200	213	67436				
	Ptr Ck Jr High Mobl		12		15			
	TOTAL	1837	4012	1739629	4295	389362	3773	355534

#	DESCRIPTION	80-1 ELEC GJ	81-2 ELEC GJ	82-3 ELEC GJ	AVG 80-3 ELEC GJ	80-1 FUEL GJ	81-2 FUEL GJ	82-3 FUEL GJ	AVG 80-3 FUEL GJ	AVG FUEL GJ	EST 83-4 FUEL GJ
206	Takhini Elem	590	452	359	467	1013	1310	975	1099	615	130
254	Takhini Mobl	29	30	21	27	106	124	106	112	112	
207	Whitehorse Elem	814	754	815	794	4116	5171	5554	4947	4996	5044
208	Selkirk Elem	1692	1687	1221	1533	7150	7200	5776	6709	7294	7880
220	St. Elias Dorm	116	143	133	131	343	439	678	487	413	340
221	F.H.Collins High	4832	4487	4301	4540	17347	17496	18856	17900	17774	17649
222	Yukon College		2097	1821	1959	9679	11968	6056	9234	8468	7703
222B	YC Annex2 Nisut			175	175			573	573	721	869
225	ChristKing Elem	324	395	316	345	2310	2910	1951	2390	3431	4471
226	ChristKing High	602	648	395	548	4059	4217	4618	4298	4385	4471
233	Jk Hulland Elem	2034	2654	1849	2179	7483	7932	7221	7545	7642	7738
258	Jeckell Jr High	2031	1707	1794	1844	7994	10332	9901	9409	8654	7900
281	Grey Mtn Primary	520	352	431	434	2159	728	1014	1300	883	466
282	Ptr Ck Jr High			766	766			2664	2664	5282	7900
	Ptr Ck Jr High Mobl		55	44	50						
	TOTAL				15793				68667	70670	72562
	AVERAGE			MWH:	293			GJ:	4905	5048	5582

TABLE 5-3b

YTG & MUNICIPAL BUILDINGS ENERGY USE: WHITEHORSE - Human Resources, Justice
SOURCE: YTG Energy Branch, YTG Supply Services Branch, YECL

#	DESCRIPTION	83-4 FUEL EST LTR*1000	82-3 ELEC MWH	82-3 FUEL LITRES	81-2 ELEC MWH	81-2 FUEL GAL	80-1 ELEC MWH	80-1 FUEL GAL
210	Pelly Blk	18			36	2671	13	2679
214	Hanson St Grp Home	27			43	4827	44	3030
220	5th Ave Res	8						
234	MacCauley Lodge	115			255	20829	236	20774
241	Klondike Grp Home	9			43	1817	26	1404
251	Liard Child Home	11			22	2430	17	1024
252	Lowe St Grp Home	8			36	1333	29	1959
253	Detox Centre	8						
286	Jeckell Grp Home				31	2032	2	1326
230	Womens Lvg Unit							
231	Wolf Ck Juvenile		77		149			
	Wolf Ck-1		unused		9			
	Wolf Ck-2		unused		75			
232	Correction Inst	25			362	3651		
	Correction Annex				24			
	TOTAL	229	77		1084	39590	367	32196

#	DESCRIPTION	80-1 ELEC GJ	81-2 ELEC GJ	82-3 ELEC GJ	AVG 80-3 ELEC GJ	80-1 FUEL GJ	81-2 FUEL GJ	82-3 FUEL GJ	AVG 80-3 FUEL GJ	AVG FUEL GJ	EST 83-4 FUEL GJ
210	Pelly Blk	48	129		89	480	479		480	585	691
214	Hanson St Grp Home	158	156		157	543	866		704	885	1067
220	5th Ave Res									308	308
234	MacCauley Lodge	848	919		883	3725	3735		3730	4127	4523
241	Klondike Grp Home	94	154		124	252	326		289	328	367
251	Liard Child Home	62	78		70	184	436		310	372	435
252	Lowe St Grp Home	105	130		118	351	239		295	306	316
253	Detox Centre									332	332
286	Jeckell Grp Home	5	113		59	238	364		301	301	
230	Womens Lvg Unit										
231	Wolf Ck Juvenile		536	276	406						
	Wolf Ck-1		31		31						
	Wolf Ck-2		269		269						
232	Correction Inst		1302		1302		655		655	821	988
	Correction Annex		85		85						
	TOTAL				3592				6764	8365	9026
	AVERAGE			MWH:	83			GJ:	846	837	1003

TABLE 5-3c

YTG & MUNICIPAL BUILDINGS ENERGY USE: WHITEHORSE - General Govt Admin
SOURCE: YTG Energy Branch, YTG Supply Services Branch, YECL

#	DESCRIPTION	83-4 FUEL EST LTR*1000	82-3 ELEC MWH	82-3 FUEL LITRES	81-2 ELEC MWH	81-2 FUEL GAL	80-1 ELEC MWH	80-1 FUEL GAL
211	Hawkins St.		28		72			
215	Bldg Maint	45	74		31	11936		9510
216	Sign shop	11	11		34	2453		2513
228	Library	45				13640		10548
244	Weigh Stn				31			
259	Admin Bldg	190	2061		2149	53319		46195
263	Suppl.Serv.Whse	14				248		351
267	Grader Stn	80	126		96	19944		16161
271	Parks & Hist Wks	20						
275	Cntrl wkshp	160				5287		21288
277	Cntrl Purch Stores							
278	Liquor Whse				220	17841	368	26218
284	Whitehorse Chalet		216	49070	271	16781		
287	Visitor Info Cntr							
	Car plgs, ht trcg, lghts				680			
	TOTAL	565	2515	49070	3634	141449	368	132784

#	DESCRIPTION	80-1 ELEC GJ	81-2 ELEC GJ	82-3 ELEC GJ	AVG 80-3 ELEC GJ	80-1 FUEL GJ	81-2 FUEL GJ	82-3 FUEL GJ	AVG 80-3 FUEL GJ	AVG FUEL GJ	EST 83-4 FUEL GJ
211	Hawkins St.		258	102	180						
215	Bldg Maint		290	266	278	1705	2140		1923	1850	1778
216	Sign shop		121	38	80	451	440		445	440	435
228	Library					1892	2446		2169	1973	1778
244	Weigh Stn		113		113						
259	Admin Bldg		7737	7419	7578	8284	9562		8923	8214	7505
263	Suppl.Serv.Whse					63	44		54	293	533
267	Grader Stn		346	452	399	2898	3577		3237	3199	3160
271	Parks & Hist Wks									790	790
275	Cntrl wkshp					3818	948		2383	4351	6320
277	Cntrl Purch Stores										
278	Liquor Whse	1323	791		1057	4702	3199		3951	3951	
284	Whitehorse Chalet		976	777	876		3009	1938	2474	2474	
287	Visitor Info Cntr										
	Car plgs, ht trcg, lghts		2448		2448						
	TOTAL				13008				25558	27535	22298
	AVERAGE			MWH:	402			GJ:	2840	2754	2787

TABLE 5-3d

CITY OF WHITEHORSE MUNICIPAL BUILDINGS - ENERGY DATA
SOURCE: City of Whitehorse Finance Department

		1980		1981		1982			
	BLDG DESCRIPTION	MWH @$60	LITRES @.34	MWH @$65	LITRES @.36	MWH @$65	LITRES @.38	AVG MWH	AVG HTG GJ
0127	CITY HALL BLDG	117	25824	124	29694	143	42682	128	1175
0126	PRCH & STORS OFF	7	5159	33	6658	20	3576	20	184
0202	FIREHALLS	102	34050	114	37661	114	56911	110	1539
0204	ANML SHLTR	41		41		54		45	
0302	2ND AVE GARAGE			83	51442	56	32674	69	1510
0303	PTR.CK. MUNIC. GRGE			5	4919	8	12939	6	321
0304	MUNIC. SERV. BLDG			99	52050	332	119595	215	3081
0311	OFFC & LNCHRM TRLR	19	2850	20	2219	23	3932	21	108
0314	STORM LIFT BLDGS	36		33	3381		29	34	61
0424	RESEVOIR BLDGS		7832		10256		21684		476
0426	WATER MATR REPR SHOP		3124		4653		6379		169
0441	WTR PMPNG & TRTMNT	2834	126626	2505				2669	4546
0452	MUNIC DUMP BLDG					36		36	
0453	MARWELL LIFT STN	1336	27971	1460	25919		26024	1398	956
	LIFT STN. EXC MRWL	345	7168	398	6119	416	17658	386	370
0721	JIM LIGHT ARENA	503	47844	470	53564	540	51855	504	1834
0722	STN McGWN ARENA	447	67368	482	111875	574	111237	501	3476
0724	WHSE REC CENTRE	63	43691	77	63506	53	32724	64	1674
0725	LIONS POOL	87	42674	79	40450	82	49276	82	1584
	OUTDR. RINKS	28		29				29	
8208	PTR.CK. SAT. STN		6618		5431				216
	TOTAL	5964	448797	6050	509797	2452	589174	4822	18522

TABLE 5-3e

GOVERNMENT FUEL REQUIREMENTS ESTIMATES - 1983-84
SOURCE: YTG Supply & Services, Fed. Govt. Supply & Services
Data in Litres X 1000

Community	YTG Bldgs	Education	Fed. Govt.	F.G. Res.
Whitehorse	190	50	7	6
	45	113	55	25
	45	447	36	25
	11	196	57	7
	80	200	51	7
	160	12	384	4
	5	3	315	2
	6	128	273	1341
	8	200	1089	7
	20	200	1183	7
	25	9	27	
	27	191	27	
	11	22	101	
	8	4	90	
	9		55	
	8		57	
	18		18	
	115		12	
	8		7	
Total Litres:	798	1773	3844	1430
Total # bldgs	30	12	297	207
GJ:	31521	70049	151830	56465
Total Govt.:	183351			
GJ per Bldg.:	1051	5837	511	273

TABLE 5-3f

WHITEHORSE COMMERCIAL BUILDING STATISTICS
SOURCE:YTG Energy Branch Surveys

	COMMERCIAL BUILDING		R values	FLOOR ft2	FUEL litres	GJ	PERIOD from:to	DD	ELEC kWh	GJ	EGJ FGJ	TOTL GJ	VOL m3	MJ/ DDY	KJ/M3 /DDY	AVGYR GJ	RPI
a2	klondike ke	wd,ofa	20/12/0	640	1105	44	801	6429	617	2	.05	46	145	7	47	47	2
a2	taakaliic k	wd,ebb	20/8/2	450	6 cds wd	96	823	6732	292	1	.01	97	145	14	98	100	10
0																	
d6	mandem ltd.	ofa	4/6/0	2912	20448	808	801	6429	27360	98	.12	906	1541	126	82	878	72
d92	arctic diam	ofa	5/20/1	2016	13154	520	801	6429	16920	61	.12	580	869	81	93	565	52
0																	
f42	decora land	ofa	1/1/0	2000	6604	261	mr-dc82	5019	5411	19	.07	280	293	52	177	363	64
f42	horizon pai	wd,ebb	5/10/1	792	4 cds wd	64		6988	16656	60	.94	124	213	9	43	64	3
0																	
g45	polaris mov	ohw	12/12/1	4036	28192	1114	812	7408	11228	40	.04	1154	2741	150	55	1050	58
g45	tnta hanger	ofa	20/3/0	13000	66381	2622	79	7033	91000	328	.12	2950	8201	373	45	2605	118
0																	
h48	nwtel headq	efa		6000	0	0		6732	507860	1828	.00	1828	1598	272	170	1898	322
h49	yecl wareho	ebb,ofa	14/14/2	7080	29760	1176	80	6838	90200	325	.28	1500	3611	172	48	1201	57
h49	yukon elect	ofa	19/16/3	3525	2522	100		6988	63720	229	2.30	329	3186	14	4	100	0
0																	
i52	whitehorse	ofa	7/14/0	9600	44302	1750	80	6838	96000	346	.20	2096	4758	256	54	1788	96
i55	auto marine	ofa	10/11/1	18000	50126	1980	823	6732	129090	465	.23	2445	7043	294	42	2055	86
i57	whs bsns mc	efa	30/15/1	1292	0	0		6732	26030	94	.00	94	322	14	43	97	4
i59	yukon suppl	ohw	5/3/1	3744	26275	1038	812	7408	6180	22	.02	1060	1021	140	137	979	134
0																	
j60	super a foo	ofa	14/18/1	8400	24939	985	81	6105	405420	1459	1.48	2444	3095	161	52	1128	59
j60	super value	ofa,lpg	5/9/2	31100	20433	4572	80	6838	1745080	6282	1.37	10854	19541	669	34	4672	160
j60	super value				138940		80	6838						0			
j62	house of fu	ofa	8/9/1	8800	19976	1898	812	7408	41120	148	.08	2046	2244	256	114	1790	204
j63	charmen mechanics		12/12/1	1800	11350	448	oc81-ap82	7361	1200	4	.01	453	612	61	100	426	42
j63	micmac moto	ofa	5/7/1	1953	3166	125	812	7408	25180	91	.72	216	664	17	25	118	3
j65	nelsons har	ofa	7/7/3	4470	14252	563		6988	45720	165	.29	728	1331	81	61	563	34
j65	northern ou	ofa	9/12/1	4026	15966	631	823	6732	42041	151	.24	782	1138	94	82	655	54
j65	whitehorse	ofa	8/12/8	738	3271	129	801	6429	3184	11	.09	141	362	20	56	140	8
j69	whitehorse	ofa	9/9/1	4550	13080	517	dc81-my82	5446	20120	72	.14	589	1363	95	70	663	46
0																	
m77	cable, veal	mfa	27/18/9	4394				7408	144540	520	.00	520	2925	70	24	491	12
m77	echo answer	ofa	12/6/0	1481	3032	120		6988	1200	4	.04	124	419	17	41	120	5
m77	grey mounta	ohw	23/5/1	3452	19225	759	823	6732	24700	89	.12	848	1982	113	57	788	45
m77	mckay & par	ofa,3ebb	5/9/2	5000	3750	148		6988	159510	574	3.88	722	2832	21	7	148	1
m77	tutshi buil	oil ?	9/9/2	6000	20757	820	801	6429	85200	307	.37	1127	3823	128	33	891	30
m77	yukon centr	mfa	5/12/0	10925				6988	262000	943	.00	943	5568	135	24	943	23
0																	
n83	cassiar bld	ohw	14/7/7	23942	119595	4724	82	7556	239000	860	.18	5584	18521	625	34	4369	147
n83	kishwoot ha	ofa	5/5/0	4677	30702	1213	801	6429	105388	379	.31	1592	1274	189	148	1318	195
o85	child devel	ofa	10/12/0	1974	10660	421		6988	10000	36	.09	457	657	60	92	421	39
p86	whitehorse	ohw/fa	10/14/10	12440	65300	2579	80	6838	219800	791	.31	3371	4047	377	93	2636	246
p86	yukon rehab	ofa	18/3/0	4400	7586	300		6988	35520	128	.43	428	1614	43	27	300	8
0																	

TABLE 5-3f (cont'd)

WHITEHORSE COMMERCIAL BUILDING STATISTICS
SOURCE:YTG Energy Branch Surveys

	COMMERCIAL BUILDING		R values	FLOOR ft2	FUEL litres	GJ	PERIOD from:to	DD	ELEC kWh	GJ	EGJ FGJ	TOTL GJ	VOL m3	MJ/ DDY	KJ/M3 /DDY	AVGYR GJ	RPI
q91	98 hotel	ebb	5/17/0	4800	0	0		6429	103860	374	.00	374	1359	58	43	406	17
q91	chilkoot mo	ohw	20/9/10	3600	7137	282		6988	110000	396	1.40	678	2753	40	15	292	4
q91	klondike in	efa	32/24/1	21600				7408	917680	3303	.00	3303	5509	446	81	3116	252
q91	klondike in	ofa&ohw	12/12/1	23625	162539	6420	812	7408	567840	2044	.32	8464	9239	867	94	6056	568
q91	new north m	ebb,ohw	6/12/6	4608	53454	2111	82	7556	472640	1701	.81	3813	3474	279	80	1953	157
q91	whitehorse	ohw,lng	8/10/0	9400	80766	3190	ja80-fb81	8345	110720	399	.12	3589	4630	382	83	2671	221
q92	kopper king	ohw	24/14/3	5004	20745	819		6988	30000	108	.13	927	1982	117	59	819	48
q92	no pop sand	ofa	10/5/5	1846	8505	336		6988	28200	102	.30	437	627	48	77	336	26
0																	
r96	guild hall	ofa	20/12/12	1875	8563	125	81	6105	18000	65	.52	190	1488	20	14	143	2
r97	qualita cle	ohw	10/4/0	3600	84884	3353	801	6429	42480	153	.05	3506	961	522	543	3644	1978
r98	carpenters	ohw	24/12/6	991	5036	199	823	6732	5774	21	.10	220	617	30	48	206	10
r98	christian b	ofa	8/6/5	1110	8720	344	81	6105	9236	33	.10	378	591	56	95	394	38
r98	church & pa	ofa	24/14/14	1040	4558	120	812	7408	5173	19	.16	138	645	16	25	113	3
r98	church 7th	o/wfa	60/24/15	2720	4552	244	812	7408	14255	51	.21	295	1542	33	21	230	5
r98	7th day adv				4 cds												
r98	church chri	ofa	5/12/8	3186	11241	444	812	7408	20702	75	.17	519	852	60	70	419	29
r98	church rive	ofa	8/14/5	3044	11959	472	fb81-fb82	7958	11820	43	.09	515	781	59	76	415	32
r98	church whit	ohw	10/13/13	2926	12514	494	801	6429	5151	19	.04	513	2861	77	27	537	14
r98	skookum jim	ofa	5/12/7	1755	10015	396	812	7408	14880	54	.14	449	883	53	60	373	23
r98	union hall(	ofa	8/20/3	1115	3506	138	801	6429	4540	16	.12	155	598	22	36	151	5
r98	whitehorse	ohw	9/13/7	3836	3730	147	80	6838	10460	38	.26	185	1883	22	11	151	2
r98	yukon missi	ohw	12/12/1	4892	11744	464	823	6732	32150	116	.25	580	3047	69	23	482	11
0																	
0	average			5825	25943	993		6879	129287	457	.35	1380	2786	144	52	1009	52

TABLE 5-3g

RCMP BUILDINGS - ENERGY USE RCMPDAT
SOURCE - RCMP, Whitehorse

		1981-82			1982-83			1982-83		
BLDG #	DESCRIPTION	ELEC MWH	$	$/kWh	ELEC MWH	$	$/kWh	FUEL (L)	$	$/L
WHITEHORSE										
200017	headqtrs	705	54707	.08	505	43075	.07			
200013	storage	N/A	N/A		N/A	N/A		17836	7004	.39
200152	air dtchmnt	90.2	7555	.08	76.5	7303	.10	23200	8518	.37
200003	cmpnd hse #3	14.4	935	.06	10.3	624	.06	6303	2235	.32
200011	cmpnd hse #4	15.5	1007	.06	8.4	503	.06	5080	1646	.32
200012	cmpnd hse #6	13.5	907	.07	12.1	762	.06	4125	1333	.32
200013	cmpnd hse #7	22.4	1444	.06	18.6	1065	.06	3673	1186	.32
200016	cmpnd hse #8	11.1	676	.06	10.8	582	.06	4047	1135	.28
200014	cmpnd hse #9	17.7	1230	.07	21.4	1342	.06	4250	1381	.32
200017	detachment	8.7	782	.09	N/A	N/A		127308	39663	.31
206057	12 Alsek	14.9	943	.06	10.8	641	.06	5747	1882	.33
205015	13 Alsek	14.5	1063	.07	15.3	931	.06	3639	1212	.33
206053	34 Alsek	12.7	858	.07	9.7	639	.07	5491	1798	.33
206004	33 Alsek	17.9	1161	.06	3.4	234	.07	N/A	N/A	
	14 Antwerp	N/A	N/A		11	653	.06	2942	943	.32
206028	18 Antwerp	23	1426	.06	27.7	1653	.06	3145	1035	.33
206031	20 Antwerp	24.6	1536	.06	18.2	1129	.06	2663	875	.33
206031	20 Antwerp	24.6		.00	N/A	N/A		N/A	N/A	
206046	26 Antwerp	31.1	1639	.05	6.2	429	.07	N/A	N/A	
206082	28 Antwerp	26.4	1653	.06	23.7	1440	.06	2554	836	.33
205114	7 Arnhem	15.3	954	.06	16.6	944	.06	2393	783	.33
206044	8 Arnhem	20.5	1283	.06	20.4	1245	.06	3043	994	.33
206064	11 Arnhem	8.6	578	.07	15.2	912	.06	2784	914	.33
205083	12 Arnhem	28.4	1758	.06	23.3	1349	.06	2737	914	.33
206084	16 Arnhem	13.5	840	.06	9.9	640	.06	3257	1074	.33
206086	20 Arnhem	10.4	735	.07	N/A	N/A		N/A	N/A	
205087	24 Arnhem	10.7	723	.07	15.2	952	.06	3106	1022	.33
206127	32 Arnhem	N/A	N/A		5.9	473	.08	1723	585	.34
	34 Arnhem	N/A	N/A		N/A	N/A		2213	713	.32
206123	36 Arnhem	N/A	N/A		11.9	684	.06	1972	639	.32
206128	41 Arnhem	15.5	1006	.06	12.8	811	.06	3306	1082	.33
206126	43 Arnhem	N/A	N/A		12	682	.06	2054	658	.32
205083	43 Arnhem	19.7	1244	.06	28.2	1586	.06	4363	1432	.33
205116	31 Casino	21.4	1361	.06	19.8	1124	.06	2528	825	.33
206047	16 Dieppe	10.8	714	.07	N/A	N/A		N/A	N/A	
206124	28 Dieppe	N/A	N/A		18.9	1062	.06	2304	759	.33
206122	38 Dieppe	N/A	N/A		16.2	1062	.07	2852	943	.33
206253	50 Dieppe	23.3	1461	.06	9.8	641	.07	3201	1050	.33
206033	52 Dieppe	20.9	1210	.06	15.2	924	.06	3338	1009	.32
	24 Donjek	N/A	N/A		8.3	545	.07	3644	1215	.33

RCMP BUILDINGS - ENERGY USE   TABLE 5-3g (cont'd)   RCMPDAT
SOURCE - RCMP, Whitehorse

		1981-82			1982-83			1982-83		
BLDG #	DESCRIPTION	ELEC MWH	$	$/kWh	ELEC MWH	$	$/kWh	FUEL (L)	$	$/L
WHITEHORSE										
206017	25 Donjek	9.9	817	.08	7.5	505	.07	4806	1568	.33
206018	29 Donjek	18.3	1164	.06	9.7	640	.07	1250	422	.34
206056	33 Donjek	26.4	1512	.06	20.9	1181	.06	1551	501	.32
206026	35 Donjek	15.3	1010	.07	15	952	.06	3012	971	.32
206063	3 Falaise	16.9	960	.06	14.3	899	.06	3652	1044	.29
206083	19 Falaise	27	1677	.06	27.6	1812	.07	2549	849	.33
206002	3 Kluhane	19.9	1278	.06	13.8	876	.06	6182	2027	.33
206091	9 Koidern	30	1705	.06	17.1	935	.06	3405	1107	.33
206081	#1 401 Lambert	1.8	165	.09	.9	107	.12N/A		N/A	
206072	#2 401 Lambert	1.9	165	.09	3.5	259	.07N/A		N/A	
206074	#3 401 Lambert	2.1	192	.09	3.4	249	.07N/A		N/A	
206078	#4 401 Lambert	3.1	241	.08	3.6	263	.07N/A		N/A	
206012	10 Lewes	5.8	365	.06N/A		N/A	N/A		N/A	
206009	14 Lewes	23.1	1462	.06	17.5	918	.05	2847	926	.33
206034	16 Normandy	19.3	1100	.06	14.7	918	.06	3668	1199	.33
206049	20 Normandy	13.3	842	.06	6.9	470	.07	3332	1075	.32
206049	20 Normandy	N/A	N/A		6.9	470	.07	843	290	.34
206092	35 Nijmegan	17.4	1108	.06	3.1	215	.07N/A		N/A	
206079	37 Nijmegan	31	1922	.06	24.7	1501	.06	3942	1270	.32
206094	6 Ortona	29.3	1790	.06	26.9	1445	.05	3247	1062	.33
206096	12 Ortona	19.1	1194	.06	22.1	1331	.06	2624	858	.33
206036	16 Ortona	15.5	1008	.07	14.9	939	.06	2606	849	.33
206051	24 Ortona	20.1	1263	.06	18.4	1121	.06	2646	864	.33
206038	71 Ortona	20.5	1281	.06	16.3	1021	.06	3139	1027	.33
206097	28 Range Rd	10.9	638	.06	8	502	.06	4063	1325	.33
206041	30 Range Rd	9	569	.06	13.2	821	.06	3650	1190	.33
206043	32 Range Rd	24	1511	.06	22.7	1382	.06	3504	1121	.32
206048	26 Seine Square	18.1	1170	.06	4.7	337	.07N/A		N/A	
206097	28 Seine Square	5794	377	.00	13.8	837	.06	4977	1638	.33
206118	9 Tagish	N/A	N/A		12.7	728	.06	3466	1120	.32
206027	24 Tagish	9.5	689	.07	10.9	614	.06	3653	1194	.33
206098	26 Tagish	19.4	1224	.06N/A		N/A	N/A		N/A	
206021	23 Tagish	13.1	858	.07	11.7	670	.06	3723	1214	.33
206022	11 Takhini	18.2	1131	.06	16.4	884	.05	3058	995	.33
206125	11 Tatchun	N/A	N/A		6.8	411	.06	3048	976	.32
206117	14 Tatchun	16.8	1109	.07	24.3	1462	.06	2701	879	.33
206062	15 Tatchun	20.9	1338	.06	17.4	1068	.06	3694	1198	.32
206007	17 Tatchun	14.3	936	.07	11.7	731	.06	4694	1540	.33
206024	34 Teslin	13.5	902	.07	11.4	775	.07	3931	1289	.33
206021	93 Valleyview	N/A	N/A	N/A		N/A		5850	1897	.32
206039	167 Valleyview	16	1033	.06	12.4	793	.06	3967	1300	.33

TABLE 5-3h

YUKON HOUSING CORP (Whitehorse housing) RESIDENTIAL UNITS (nCHANGE)

Source: YTG Energy Branch, Yukon Housing Corp

TYPE OF UNIT	#	Year	Volume htd M3	R-roof/ R-wall %
Apartment	24		133	
Apartment	20	63	113	
Apartment	18		121	
Apartment	36	71	116	
Row house	43	75	376	20/12
Duplex	10	75	347	20/12
SFD	3	73	290	30/12

	1980-81 ELECTRICITY kWh				FUEL OIL litres					
	low	mean	high	total MWh	low	mean	high	total	MEAN MJ/M3	MEAN kJ/M3/DD
Apartment		10686		256.46	elec.hts					
Apartment		2562		51.24		1830		36605	540	122
Apartment		2392		43.06		1579		28420	327	51
Apartment										
Row house	5546	13749	24482	591.21	1663	3138	4375	134936	330	51
Duplex	2856	9097	15767	90.97	1613	2438	4110	24385	284	44
SFD	12756	15237	17244	45.71	3459	3714	4122	11142	506	79
				1278.66		kilolitre		.275		
						litres/DD		36.72		

	1981-82 ELECTRICITY kWh				FUEL OIL litres					
	low	mean	high	total MWh	low	mean	high	total	MEAN MJ/M3	MEAN kJ/M3/DD
Apartment		13627		327.04	elec.hts					
Apartment		3420		68.40		1619		32374	566	76
Apartment		2729		49.12		1650		29691	341	45
Apartment		7051		253.84		1906		68630	549	38
Row house	9957	15149	23757	534.40	1970	3643	5257	156652	383	52
Duplex	7470	9923	15190	99.23	2115	3096	4555	30962	351	47
SFD	14389	17294	20675	87.12	4032	4353	4991	13059	593	80
				1579.20		kilolitre		.331		
						litres/DD		44.72		

TABLE 5-3i

PIONEER GRANT HOUSES - 1983 RESIDENTIAL RETROFIT DEMONSTRATION
CREDA Project #3766-4-25

YEAR BUILT	VOLUME M3	82-83 ELEC KWH/DAY	ELEC KWH/YEAR	82-83 HEATING KWH/DD	81-82 HEATING KWH/DD	WOOD HEATING KWH/DD	% WOOD HTG	TOTAL HEATING KWH/DD	KJ/M3 /DD	AVGYR GJ	******
WHITEHORSE											
78	392	36	13140	5.2	5.2			5.20	48	129	6
78	519	20	7300	3.4	3.6			3.50	24	87	2
78	806	43	15695	5.8				5.80	26	144	4
78	290	55	20075	3.5	5.3	1.3	23	5.70	71	141	10 *
77	118	16	5840	1.3	1.2			1.25	38	31	1
77	184	23	8395	3.7	3.6			3.65	71	91	6 *
77	246	21	7665	2.8				2.80	41	69	3
76	362	20	7300	2.9		3.6	55	6.50	65	161	10 *
76	408	26	9490	9.4	8.5	1.3	13	10.25	90	254	23 ***
76	420	11	4015	.5		7	93	7.50	64	186	12 *
76	320	37	13505	1.9	2.1			2.00	23	50	1
76	290	34	12410	2.1	.8			1.45	18	36	1
75	831	44	16060	7.5	7.4			7.45	32	185	6
75	521	43	15695	5.2	5.1			5.15	36	128	5
74	547	44	16060	5.8	4.7			5.25	35	130	4
74	498	31	11315	6.1				6.10	44	151	7 *
73	400	13	4745	1.2	1.1	4.1	78	5.25	47	130	6
73	522	25	9125	6.1	6.1			6.10	42	151	6
72	140	20	7300	1.8	2.1	3.4	64	5.35	138	133	18 **
72	226	30	10950	6.2	6.4			6.30	100	156	16 **
70	373	33	12045	3.8	6.3	4.4	47	9.45	91	234	21 ***
70	610	49	17885	9.1	12.4			10.75	63	267	17 **
69	648	74	27010	9.1				9.10	51	226	11 *
69	165	30	10950	4.2	4.8			4.50	98	112	11 *
68	261	23	8395	3.7	4.1			3.90	54	97	5
64	460	35	12775	4.9	4.6			4.75	37	118	4
63	453	38	13870	7.1	7.1			7.10	56	176	10 *
62	401	27	9855	1.3	4.2	1.3	32	4.05	36	100	4
61	387	31	11315	4.7	4.6			4.65	43	115	5
61	427	21	7665	3.3	3.1	2.7	46	5.90	50	146	7 *
61	339	34	12410	3.9	3.9			3.90	41	97	4

TABLE 5-3i (cont'd)

PIONEER GRANT HOUSES - 1983 RESIDENTIAL RETROFIT DEMONSTRATION
CREDA Project #3766-4-25

YEAR BUILT	VOLUME M3	82-83 ELEC KWH/DAY	ELEC KWH/YEAR	82-83 HEATING KWH/DD	81-82 HEATING KWH/DD	WOOD HEATING KWH/DD	% WOOD HTG	TOTAL HEATING KWH/DD	KJ/M3 /DD	AVSYR GJ	******
WHITEHORSE											
55	310	26	9490	5.3	5.4			5.35	62	133	8 *
54	416	24	8760	8.4	7.5			7.95	69	197	14 **
53	267	30	10950	6.1				6.10	82	151	12 *
53	390	35	12775	4.4	4.4			4.40	41	109	4
53	321	31	11315	1.4	2.8	3.9	65	6.00	67	149	10 *
53	319	13	4745	4.1	3.9			4.00	45	99	4
53	396	61	22265	7.3	8.1	3.3	30	11.00	100	273	27 ****
53	628	31	11315	7.7	9.4	.7	8	9.25	53	229	12 *
53	312	26	9490	2.5		4.1	62	6.60	76	164	12 *
44	157	19	6935	3.8	3.5			3.65	84	91	8 *
43	273	30	10950	4.1	3.6			3.85	51	95	5
43	400	20	7300	4.1		2.7	40	6.80	61	169	10 *
43	386	30	10950	4.4	5.2	1.3	21	6.10	57	151	9 *
43	512	40	14600	6.6	6.6			6.60	46	164	8 *
40	279	18	6570	5.3	5.3			5.30	68	131	9 *
8	331	37	13505	4.6	4.1	2.1	33	6.45	70	160	11 *
AVERAGE											
63	389	31	11323	4.63	4.95	2.95	44	5.74	57.60	154	9

5.2.2 Watson Lake

5.2.2.1 Cultural and Economic Setting

Originally inhabited by the Kaska Indians, the area is named after a prospector who liked the area so much that he married a native woman and settled here. As a spinoff from the gold rush, a store was erected at the current townsite in 1887. Watson Lake did not become an accommodation and supply center until the construction of the airport in 1941 and then serviced Alcan in 1942. In 1963 the Campbell Highway was completed. Watson Lake is now the key transportation, communication and distribution center with linkages to the Cantung area in the North West Territories and to the Stewart-Cassiar area in British Columbia. It is also a service area for tourists.

5.2.2.2 Community Energy Planning for Watson Lake

If the community of Watson Lake wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Watson Lake.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Watson Lake, then the estimated space heating load of 133000 Gigajoules could be reduced by 50 percent to 66500 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Watson Lake, the other sector which uses a large proportional amount of energy for space heating is the Yukon and Municipal Government sector. Yukon and Municipal Government buildings consume 8 percent of the space heating fuel and comprise only 3 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public buildings will offer the most favorable conservation/retrofit opportunities.

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementation of energy conservation. People from communities throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to

TABLE 5-4

COMMUNITY ENERGY PROFILE: WATSON LAKE POPULATION: 1141

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL SPHT GJ	%	TOTAL GJ	%
FED GOVERNMENT	20	3	24	480	5	450	9000	7	10727	7
YUKON & MUNICPL GOVT	17	3	24	408	5	600	10200	8	11668	7
EDUCATION	2	0	195	390	4	4500	9000	7	10404	6
COMMERCIAL	105	17	32	3382	38	260	27300	21	39464	24
FED GOVT RESIDENTIAL	15	2	20	300	3	140	2100	2	3179	2
YUKON HSG CORP	47	8	12	578	6	160	7520	6	9599	6
RESIDENTIAL	332	53	8	2655	30	140	46430	35	55979	34
RESIDENTIAL (ttl wd)	88	14	8	707	8	238	21030	16	23574	14
TOTAL	626			8900			132579		164594	
TOTAL RESIDENTIAL	482			4240						

GJ USED PERCAPITA 144

kWh/litre gen eff: 3.33 105571 GJ

TOTAL GJ INPUT: 238150

GJ INPUT PERCAPITA 209

energy conservation. Beginning in 1984, Yukon College, through the Education Extension Program will offer courses in Watson Lake for those who are interest in retrofit technology, energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved. This will result in reductions of oil use, both through direct space heating and energy requirements for fuel transport. Residential buildings sampled in Watson Lake for this study, indicate retrofit potential indices (RPI) as high as 34. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in Watson Lake and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load ranges from 140 to 238 Gigajoules per household. The lower figure undoubtably reflects seasonal occupation of the houses and/or the utilization of wood as a supplementary heating fuel. The upper figure represents totally wood heated households. Three factors contribute to this high value. Firstly, the typical inefficiency of most wood burning appliances, secondly, the inaccuracy of estimated "cord" value, and thirdly, the residences which use wood as the primary heating source are generally less thermally efficient than other residences in the community.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

The diesel fueled electric generator in Watson Lake uses an estimated 10600 Gigajoules per year. It may be possible to recover much of this energy as available waste heat. After conservation, the net space heating load of 66500 Gigajoules could be further offset by the recovery of waste heat from the generator. This available energy should be specifically evaluated in terms of identifying buildings which have sufficiently high heating demands, and are close enough to the power plant to make heat transmission effective.

Other energy supply options for Watson Lake are discussed in the following sections.

5.2.2.3 Alternatives for Reducing Oil Consumption

(a) Wood

Like Dawson City, Watson Lake is large enough to require electrical generation alternatives of the order of 5 to 6 MW assuming much of the space heating demand was also converted to electric.

In this range, generation of electricity from wood waste together with heat recovery for process heat is clearly feasible and economically justified. However, the cogeneration scheme contemplated there by Cattermole Timber has been put into jeopardy with the company going into recerverships. Even if someone else was willing to operate the electric generation facility, without the waste wood from the sawmill operation, the project cannot proceed.

A cogeneration facility associated with a sawmill is particularly attractive because the fuel is already present and if not used in this way, represents a disposal problem for the mill. Thus, cogeneration plants are common in the forest industry.

If the wood fuel must be collected specifically for a generation plant, the economics become less favourable. Nevertheless, the wood resource in the Watson Lake region are substantial and its better utilization certainly deserves further consideration. See the comments on wood supply and wood fired electrical generation in Section 5.1.2.

(b) Hydro

Several potential hydroelectric sites appear to be available in the Watson Lake region. YECL has made some preliminary investigations of a site on Watson Creek and reportedly has determined that a 1.5 to 2 MW could be developed. Large scale sites on the Liard River have also been identified by B.C. Hydro, but development of these could be many years away. In the long run, connection of Watson Lake to one of these would be the preferred alternative.

Other sites identified in the course of this study for small hydro development include Allen Creek, the Meister River and the Middle Canyon of the Francis River. Allen Creek does not appear very promising on the basis of the desk-top review but the other two locations show some promise. The Francis River site is actually capable of generation well in excess of the community's requirements.

The feasibility of a smaller development within the economic range for the community, would have to be studied further. The comments on small hydro development in Section 5.1.2 would apply here.

(c) Heat Recovery

Unless, or until, the diesel generators at Watson Lake are displaced, heat recovery to supply the district at the west end of town should be pursued. A recreation centre and school are also in the vicinity and would be the most likely candidates for space heating from the system. Residential and commercial buildings could also be considered, although it is usually not economic to serve an area of single family detached housing. Refer to the general comments on heat recovery in Section 5.1.2.

5.2.2.4 Energy Use Data Tables for Watson Lake

TABLE 5-5a

YTG & MUNICIPAL BUILDINGS ENERGY USE: WATSON LAKE
SOURCE: YTG Energy Branch, YTG Supply Services Branch, YECL

#	DESCRIPTION	83-4 FUEL EST LTR*1000	82-3 ELEC MWH	82-3 FUEL LITRES	81-2 ELEC MWH	81-2 FUEL GAL	80-1 ELEC MWH	80-1 FUEL GAL
810+	Schools	229	229	230915	429	54463	512	30363
831	Grader Sta	40	50	51899	53	9992		9478
815	Admin Bldg	55	114		125	14559		16299
836	Heated Storage	35	11	49472	12	9494		9478
830	Pumphse/wtr trtmnt	10	4	9499	5	2458		8699
851	Wildlife Bldg	9						
823	Group Home	8			29	1865	29	2969
834	Bldg maint workshop	8	4		5	1256		3223
820	Weigh Station	4	46		52	1134		1128
808	Tourist Info Cntr							
812	Bldg Maint Storage		2					
833	Storage/workshop				1			
	Tfk & St Lights				245		212	
	TOTAL	398	460	341785	754	95221	754	81637

MUNICIPAL GOVT BUILDINGS: Community Hall, Curling Rink, Skating Rink, Museum, Pool, Anml Shltr, Sewage Lift

BAND COUNCIL BUILDINGS:

#	DESCRIPTION	80-1 ELEC GJ	81-2 ELEC GJ	82-3 ELEC GJ	AVG 80-3 ELEC GJ	80-1 FUEL GJ	81-2 FUEL GJ	82-3 FUEL GJ	AVG 80-3 FUEL GJ	AVG FUEL GJ	EST 83-4 FUEL GJ
810+	School	1844	1546	825	1405	5445	9767	9121	8111	8582	9053
831	Grader Sta		189	179	184	1700	1792	2050	1847	1714	1580
815	Admin Bldg		449	411	430	2923	2611		2767	2470	2173
836	Heated Storage		42	38	40	1700	1703	1954	1785	1584	1383
830	Pumphse/wtr trtmnt		18	15	16	1560	441	375	792	593	395
851	Wildlife Bldg									356	356
823	Group Home	106	105		105	532	334		433	371	308
834	Bldg maint workshop		17	15	16	578	225		402	359	316
820	Weigh Station		186	165	176	202	203		203	184	166
808	Tourist Info Cntr										
812	Bldg Maint Storage			8	8						
833	Storage/workshop		2		2						
	Tfk & St Lights	763	881		822						
	TOTAL				3203				16340	16212	15729
	AVG w/o school, grader stn, st lights			MWH:	28			GJ:	1064	845	728

TABLE 5-5b

GOVERNMENT FUEL REQUIREMENTS ESTIMATES - 1983-84
SOURCE: YTG Supply & Services, Fed. Govt. Supply & Services
Data in Litres X 1000

Community	YTG Bldgs	Education	Fed. Govt.	F.G. Res.
Watson Lake	55	141	8	6
	8	88	114	6
	10		53	38
	40		64	38
	35			
	4			
	8			
	9			
Total Litres:	169	229	239	90
Total # bldgs	11	2	20	15
GJ:	6676	9053	9425	3539
Total Govt.:	16100			
GJ per Bldg.:	607	4527	471	236

TABLE 5-5c

RCMP BUILDINGS - ENERGY USE: WATSON LAKE
SOURCE - RCMP, Whitehorse

	VOL	81-82	MJ/DDY	82-83	MJ/DDY	82-83	AVG YR	KJ/M3		83-4 FUEL EST	
DESCRIPTION	(M3)	LITRES		LITRES		MWH	GJ	/DDY	RPI	litres	GJ
WATSON LAKE		DDY=	8131	DDY=	7777		7765				
Det/ofc	393	7886	38	5591	28	28	259	85	22	91000	3595
guardrm/cellblock	471	4535	22	5044	26	25	185	51	9		
garage/workshop	342	2915	14	4032	20	2	134	51	7		
warehouse/storage	184			1836	9		72	51	4		
single qtrs	432	3509	17	5092	26	16	167	50	8		
MQ	432	3687	18	4095	21	21	150	45	7		
MQ	432	3246	16	4174	21	27	144	43	6		
MQ DW 1976	272	1828	9	2684	14	19	87	41	4		
MQ DW 1976	272	2561	12	2963	15	21	107	51	5		
MQ DW 1978	272	2449	12	2673	14	23	99	47	5		
AVERAGE	350	3624	18	3818	19	20	140	53	8	91000	359
TOTAL	3502	32616	158	38184	194	182	1368	50		91000	3595 2.63

TABLE 5-5d

COMMERCIAL ELECTRICITY: WATSON LAKE
SOURCE:YTG Econ Devt Branch
Yukon Business Directory, NorthwesTel Directory

	82-83 MWH	ELEC GJ	$/MWH	#	IC
CML	15.44	56	20.00	1	D6
CML	.89	3	48.80	1	D6
CML	17.73	64	24.30	1	G45
SHOP	8.72	31	22.50	1	E30
SHOP	11.43	41	21.90	1	J63
GARAGE	20.68	74	21.70	1	J63
GARAGE	13.54	49	19.00	1	J63
CAFE	23.15	83	18.70	1	Q92
MOTEL	24.84	89	16.70	1	Q91
MOTEL	12.12	44	23.00	1	Q91
				5	Q91
				6	Q92
				1	R96
				4	R98
				1	R97
				6	R99
				6	F40
				6	F42
				17	G45
				3	J60
				2	J61
				1	J62
				10	J63
				9	J64
				1	J69
				2	E25
				1	E35
				2	I51
				1	I57
				1	I59
				1	K70
				1	D61
				1	L76
				2	M77
				1	D92
				1	G47
				2	H48
				1	G49

AVG MWH	14.85		
		AVG $/MWH	23.66
TOTAL MWH	149		
OTHER COM	95		
TOTAL COM	105		

TABLE 5-5e

COMMERCIAL BUILDING ENERGY USE: WATSON LAKE
SOURCE: YTG Energy Branch Commercial Energy Audits

BUILDING	VOLUME M3	ELEC MWH	PERIOD	FUEL LITRES	PERIOD	DDY	FUEL GJ	MJ /DDY	AVG YR GJ	KJ/M3 /DDY	RPI
									7766		
HARDWARE	567	10	101.112	5403	10.111	7751	213	28	214	49	10
AUTO W.L.Motors	2922	48	101.112	41016	101.110	4387	1620	369	2868	126	362
AUTO Kel Tire	604	16	204.304	6749	205.304	7162	267	37	289	62	18
HANGER Frontier	1417	49	206.306	15593	205.304	7162	143	20	155	14	2
SHOP N.W.TEL	190	6	204.303	6895	204.303	6807	272	40	311	211	65
N.W.TEL	978	59	204.303	8598	205.304	7162	340	47	368	49	18
AVERAGE	1113	31		14042		6739	476	90	701	85	79

TABLE 5-5f

GOVERNMENT OF CANADA HEATING ASSISTANCE PAYMENTS:WATSON LAKE
SOURCE:YTG Dept. of Finance
PERIOD:1 Ap82-31 Mr83 MAXIMUM $/LITRE: .44

TYPE	AREA	VOLUME M3	PERIOD	LITRES	GJ	MJ/DDY	AVG YR GJ	KJ/M3 /DDY	RPI *******
		DDY50-80=	7766		DDY82-83=	7777			
CAFE,	2000	453	211.303	9231	365	47	364	103	38 *****
RPVT,	1150	261	209.303	4287	169	22	169	94	14 **
RPVT,	2464	559	204.303	3762	149	19	148	34	5
PVT,C	720	163	210.303	3421	135	17	135	106	14 **
PVT,I	1000	227	210.303	3834	151	19	151	86	13 **
PVT,M	1000	227	204.303	4230	167	21	167	95	16 **
PVT,R	816	185	210.303	2618	103	13	103	72	7 *
PVT,T	780	177	204.303	2898	114	15	114	83	10 *
AVG	1133	257		3579	141	18	141	80	11 *

TABLE 5-5g

YUKON HOUSING RENTAL UNITS: WATSON LAKE
SOURCE: YTG Energy Branch, Yukon Housing Corp

BUILDING	YEAR	VOLUME M3	80-81 LITRES	MJ/DDY	81-82 LITRES	MJ/DDY	81-82 LEC KWH	AVG YR GJ	KJ/M3 /DDY	RPI	******
WATSON LAKE				7058		8131		7766			
senior citizen com.	80	840	6719	38	14001	68	23823	410	63	26	****
4 x 1bdrm. suite		952	15658	88	23363	113	21433	781	106	82	******
2bdrm.duplex		435	7409	41	9384	46	23778	338	100	34	*****
modular dbl.wide		218	3387	19	4004	19		149	88	13	**
3bdrm. detached		163	3169	18	3582	17		136	108	15	**
4bdrm. detatched		163	3232	18	3151	15		130	102	13	**
3bdrm detatched	70	415			3292	16		124	38	5	
		415	3859	22	1757	9		117	36	4	
		415	4240	24	4413	21		175	54	10	*
		415	3714	21	3927	19		155	48	7	*
		415	3083	17	3346	16		130	40	5	
		415	3759	21	5108	25	7707	178	55	10	*
		415	4944	28	4367	21	4412	190	59	11	*
		415	3641	20	4318	21		161	50	8	*
AVERAGE		415	3891	22	3816	19	6060	154	48	8	*
duplex	72	286	4340	24	4127	20	7618	172	77	13	**
		286	4463	25	4345	21	8348	179	81	14	**
		286	3727	21	4186	20	10436	160	72	12	*
		286	3768	21	3986	19	11360	157	71	11	*
		286	4467	25	3982	19	9302	172	77	13	**
		286	4608	26	3973	19	12687	175	79	14	**
		286	3459	19	3314	16	13997	138	62	9	*
		286	2937	16	3691	18	8689	133	60	8	*
		286	3982	22	3668	18	19110	156	70	11	*
		286	3759	21	3623	18	18292	150	68	10	*
AVERAGE		286	3951	22	3889	19	11984	159	72	12	*

TABLE 5-5g (cont'd)

YUKON HOUSING RENTAL UNITS: WATSON LAKE
SOURCE: YTG Energy Branch, Yukon Housing Corp

BUILDING	YEAR	VOLUME M3	80-81 LITRES	MJ/DDY	81-82 LITRES	MJ/DDY	81-82 LEC KWH	AVG YR GJ	KJ/M3 /DDY	RPI	******
WATSON LAKE				7058		8131		7766			
bilevel split	74	355	4045	23	4163	20	12794	166	60	10	*
		355	4268	24	4871	24	16480	185	67	12	*
		355	4027	23	4408	21	18288	171	62	11	*
		355	4227	24	4190	20	13211	171	62	11	*
		355	3641	20	4722	23	14448	168	61	10	*
		355	3800	21	4785	23	13025	173	63	11	*
		355	4654	26	4358	21	14569	183	67	12	*
		355	4109	23	4190	20	12332	168	61	10	*
		355	3441	19	4585	22	10306	161	59	9	*
		355	3709	21	3691	18	12353	150	55	8	*
		355	3823	21	4245	21	11401	163	59	10	*
		355	3568	20	3850	19	14202	150	55	8	*
		355	3709	21	4395	21	9497	164	59	10	*
		355	3410	19	3882	19	14123	147	53	8	*
		355	3936	22	3913	19	16583	159	58	9	*
		355	3741	21	4454	22	14618	165	60	10	*
		355	4259	24	4100	20	11498	170	62	10	*
AVERAGE		355	3904	22	4283	21	13513	166	60	10	*
TOTAL AVERAGE		365	4289	24	4811	23	13208	184	65	12	*
SFD AVERAGE		337	3866	22	4023	20	12289	159	63	10	*

5.2.3 Dawson City

5.2.3.1 Cultural and Economic Setting

This historical city lies on a diked plateau at the confluence of the Yukon and Dawson Rivers. Once a rich, bawdy, gold rush city, it reached its peak in 1898 with 40,000 inhabitants, telephone service, running water, and a steam boat service. It is now a mining town and, as a National Historic Site, a tourist center. Although no longer the capital, Dawson City still acts as a government service center for the northern Yukon communities. Currently, less than 20% of the inhabitants are Natives. The city has a low population density of 15 persons/hectare. There are large empty lots mixed with seasonally occupied premises which require different services and utilities.

5.2.3.2 Community Energy Planning for Dawson City

If the community of Dawson City wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Dawson City.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Dawson City, then the estimated space heating load of 147000 Gigajoules could be reduced by 50 percent to 73500 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Dawson City, the other sector which uses a large proportional amount of energy for space heating is the Yukon and Municipal Government sector. Yukon and Municipal Government buildings consume 7 percent of the space heating fuel and comprise only 3 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public buildings will offer the most favorable conservation/retrofit opportunities.

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementation of energy conservation. People from communities throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to

TABLE 5-6

COMMUNITY ENERGY PROFILE: DAWSON CITY POPULATION: 900

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL SPHT GJ	%	TOTAL GJ	%
FED GOVERNMENT	91	15	20	1820	26	330	30000	20	36547	21
YUKON & MUNICPL GOVT	18	3	20	360	5	600	10800	7	12095	7
EDUCATION	1	0	284	284	4	5945	5945	4	6967	4
COMMERCIAL	90	15	16	1436	21	350	31500	21	36665	21
FED GOVT RESIDENTIAL	39	7	14	546	8	230	8970	6	10934	6
YUKON HSG CORP	57	10	13	741	11	157	8949	6	11614	7
RESIDENTIAL	224	38	6	1380	20	152	34018	23	38982	23
RESIDENTIAL (ttl wd)	70	12	6	433	6	238	16708	11	18265	11
TOTAL	590			7000			146889		172069	
TOTAL RESIDENTIAL	390			3100			GJ USED PERCAPITA		191	
	kWh/litre gen eff: 3.00			92167	GJ		TOTAL GJ INPUT:		239056	
							GJ INPUT PERCAPITA		266	

energy conservation. Beginning in 1984, Yukon College, through the Education Extension Program will offer courses in Dawson City for those who are interest in retrofit technology, energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved. This will result in reductions of oil use, both through direct space heating and energy requirements for fuel transport. Residential buildings sampled in Dawson City for this study, indicate retrofit potential indices (RPI) as high as 35. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in Dawson City and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load ranges from 152 to 238 Gigajoules per household. The lower figure undoubtably reflects seasonal occupation of the houses and/or the utilization of wood as a supplementary heating fuel. The upper figure represents totally wood heated households. Three factors contribute to this high value. Firstly, the typical inefficiency of most wood burning appliances, secondly, the inaccuracy of estimated "cord" value, and thirdly, the residences which use wood as the primary heating source are generally less thermally efficient than other residences in the community.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

The diesel fueled electric generator in Dawson City uses an estimated 92000 Gigajoules per year. It may be possible to recover much of this energy as available waste heat. After conservation, the net space heating load of 73500 Gigajoules could be further offset by the recovery of waste heat from the generator. This available energy should be specifically evaluated in terms of identifying buildings which have sufficiently high heating demands, and are close enough to the power plant to make heat transmission effective.

Other energy supply options for Dawson City are discussed in the following sections.

5.2.3.2 Energy Supply Alternatives

(a) Heat Recovery

It is understood that NCPC and Yukon Housing Corporation are investigating the possibility of waste heat recovery. Based on the level of electrical generation at Dawson, close to 25,000 GJ of energy are available from a heat recovery system. This is the equivalent of the heating demands of about 160 households. The general comments on heat recovery distribution apply here.

(b) Hydro

Hydro generation on the North Fork of the Klondike River has been proposed, but thus far, water use permits have been denied due to fisheries conflicts. This plant was planned for a 3 to 5 MW installed capacity and involves the renovation of a plant used until the 1960's. Previously, this site had 10 MW installed.

A key question facing the development of hydro at Dawson is the capital cost and resulting unit cost for energy. Clearly, one of the main hurdles in supplying hydro to small communities is that the demand is so low that the unit cost is high. Nevertheless, given a concerted electrification effort in Dawson, the economies could improve enough to make hydro an attractive alternative.

Moreover, in addition to the town distribution system, there is some transmission line in place serving surrounding mining operations, some of which might be salvageable.

Hydro also looks attractive in Dawson because other alternatives are limited. Wood resources are scarce, grid extension is too costly, and there are no other obvious ways of generating electricity than by diesel power.

Existing net demand for energy in all sectors is about 75,000 GJ in Dawson. This corresponds to around 27,000 MWh. Assuming a load factor of 60 percent, a 5 to 6 MW plant would be warranted. Refer to the general comments on small hydro developments in Section 5.1.2.

(c) Coal

Coal resources are known to exist in the Dawson area and have been previously mined. There are no mines currently in production. Probably the best use for coal, assuming neither of the previous alternatives is adopted, is for individual building space heating. Coal is not likely to be economic for electrical generation, although a thermal generating station did once operate at Dawson.

(d) Biogas

Biogas, or methane, derived from fermentation of sewage could be utilzed in Dawson. With a population of about 1,000, a biogas digester system receiving community biological waste materials only, would produce a net gas daily output equivalent to about 60 litres of fuel oil in heat content. While Dawson is large enough to support a biogas system, its overall impact on energy supply will be minimal. See general comments regarding biogas in Section 5.1.2.

(e) Wood

Greater use of wood for space heating would directly displace oil. Wood resources in the area are not sufficiently abundant to support a large scale electrical generation system. The nearest site for collecting fire-killed wood is about 60 kilometers north on the Dempster Highway. This stand, killed in 1982, contains about 640 hectares of medium density wood. Assuming a volume of about 70 m^3 per hectare, this area represents about 300,000 GJ of energy, or just over 5 years supply for the present household heating demands of Dawson. Therefore, while this cannot be considered a really long-term resource, it does offer the potential for displacing a significant volume of oil over the short to medium term. Eventually, ancther supply area would be required.

A larger fire kill area north of the town has poor access and is reported to have only sparse stands. Live tree distribution around Dawson is also relatively sparse. Given the distance to the firekill area on the Dempster Highway, some incentive for an integrated community collection system should be investigated.

5.2.3.4 Energy Use Data Tables for Dawson City

TABLE 5-7a

YTG & MUNICIPAL BUILDINGS ENERGY USE: DAWSON CITY
SOURCE: YTG Energy Branch, YTG Supply Services Branch, YECL

#	DESCRIPTION	83-4 FUEL EST LTR*1000	82-3 ELEC MWH	82-3 FUEL LITRES	81-2 ELEC MWH	81-2 FUEL GAL	80-1 ELEC MWH	80-1 FUEL GAL
541	Robert Serv School	148	323	130566	252	35287	277	27123
551	Grader Stn	15				3833		2712
542	Firhl,libry,liq str	50				6407		9066
544	Airprt term	20				3341		2820
547	Sunset Sr Ctz Home							11384
548	Bldg Maint shop	5				1584		874
553	Area wkshop	30				7418		2351
554	Area hdqtrs bldg	9				1728		
561	Admin Bldg (old)							
562	Alex McDnld Lodge	34			119	12392	139	11988
567	Child Grp Home							
570	Wildlife Branch	15						
572	Tourist Info Cntr				5		6	
573	Carnegie Library							
	Tfk & St Lights		97		97		97	
	TOTAL	325	420	130566	473	71990	518	68318

MUNICIPAL GOVT BUILDINGS: 8: Rec Cntr, Shop/Gar, Pmphse (x4), Screening plnt, Sewg Lift Stn

BAND COUNCIL BUILDINGS: 4: Band ofc, Comm Hall, Washouse/Laundry, Fish packing Plan.

#	DESCRIPTION	80-1 ELEC GJ	81-2 ELEC GJ	82-3 ELEC GJ	AVG 80-3 ELEC GJ	80-1 FUEL GJ	81-2 FUEL GJ	82-3 FUEL GJ	AVG 80-3 FUEL GJ	AVG FUEL GJ	EST 83-4 FUEL GJ
541	Robert Serv School	998	907	1163	1023	4864	6328	5157	5450	5642	5834
551	Grader Stn					486	687		587	590	593
542	Firhl,libry,liq str					1626	1149		1387	1681	1975
544	Airprt term					506	599		552	671	790
547	Sunset Sr Ctz Home					2041			2041	2041	
548	Bldg Maint shop					157	284		220	209	198
553	Area wkshop					422	1330		876	1030	1185
554	Area hdqtrs bldg						310		310	333	356
561	Admin Bldg (old)										
562	Alex McDnld Lodge	499	428		463	2150	2222		2186	1755	1323
567	Child Grp Home										
570	Wildlife Branch									593	593
572	Tourist Info Cntr	20	19		20						
573	Carnegie Library										
	Tfk & St Lights	349	349	349	349						
	TOTAL				1855				13610	14545	12845
	AVG w/o school, grader stn, st lights			MWH:	67			GJ:	1082	1039	917

TABLE 5-7b

GOVERNMENT FUEL REQUIREMENTS ESTIMATES - 1983-84
SOURCE: YTG Supply & Services, Fed. Govt. Supply & Services
Data in Litres X 1000

Community	YTG Bldgs	Education	Fed. Govt.	F.G. Res.
Dawson	20	148	59	6
	13	3	38	6
	30		38	6
	9		75	6
	50		64	6
	5		18	3
	34		9	7
	15		9	9
			12	5
			23	5
			4	6
			5	6
			9	12
			9	24
Total Litres:	178	151	371	107
Total # bldgs:	14	1	91	39
GJ:	7011	5945	14666	4234
Total Govt.:	21678			
GJ per Bldg.:	501	5945	161	109

TABLE 5-7c

RCMP BUILDINGS - ENERGY USE: DAWSON CITY
SOURCE - RCMP, Whitehorse

	VOL	81-82	MJ/DDY	82-83	MJ/DDY	82-83	AVG YR	KJ/M3		83-4 FUEL EST	
DESCRIPTION	(M3)	LITRES		LITRES		MWH	GJ	/DDY	RPI	litres	GJ
DAWSON CITY		DDY=	8594	DDY=	7446		8409				
Detachment	790	5682	26	4432	24	32.9	209	31	7	38100	1505
garage	300	4462	21	7080	38	2	244	97	24		
single quarters	262	4307	20	4719	25		188	86	16	6000	237
MQ	461	5897	27	5010	27	41.4	226	58	13	6000	237
MQ	252	5128	24	5346	28	12.5	218	103	22	6000	237
MQ	252	5128	24	7880	42	14.4	275	130	36	6000	237
MQ	252	5180	24	6310	33	26.1	241	114	27	6000	237
AVERAGE	367	5112	23	5825	31	21.55	229	74	21	11350	384
TOTAL	2568	35784	164	40777	216	129.3	1601	74		68100	2690
											1.68

TABLE 5-7d

COMMERCIAL ELECTRICITY: DAWSON CITY
SOURCE:YTG Econ Devt Branch
Yukon Business Directory, NorthwesTel Directory

	82-83 MWH	ELEC GJ	$/MWH	#	IC
GARAGE	7.10	26	21	1	J63
HOTEL	26.59	96	20.4	1	Q91
MOTEL	15.91	57	22	1	Q91
THEATRE	5.76	21	30.7	1	R96
CAFE	11.04	40	20.9	1	R92
STORE	9.57	34	21	1	J65
REC CENTR	9.78	35	23.7	1	R96
REC CENTR	60.48	218	19.8	(1)	N83
TRST INFO	34.02	122	26	1	R98
SHOP	13.55	49	25	1	R99
				3	F40
				6	F42
				7	G45
				3	J64
				4	J63
				2	D92
				(21)	D61
				4	R96
				1	R97
				10	R98
				5	R99
				14	Q91
				5	Q92
				6	J65
				2	O85
				2	D6
				1	D9
				2	J60
				2	E24
				2	E25
				2	P86
				1	E28
				1	B32
				1	I51
				1	I59
				1	A15
				1	K70
				1	H48
				1	G49

AVG MWH	18.28		
		AVG $/MWH	23.05
TOTAL MWH	146		
OTHER COM	92		
TOTAL COM	100		

TABLE 5-7e

COMMERCIAL BUILDING ENERGY USE: DAWSON
SOURCE: YTG Energy Branch Commercial Energy Audits

BUILDING	VOLUME M3	ELEC MWH	PERIOD	FUEL LITRES	PERIOD	DDY	FUEL GJ	MJ/DDY	AVG YR GJ	KJ/M3 /DDY	RPI
									8409		
GEN.STORE	1270	190	103.202	9531	103.204	9371	376	40	338	32	11
APARTMENT	902	16	105.204	9599	103.204	9371	379	40	340	45	15
SALOON Gerties	3599	47	103.201	26606	103.202	7075	1051	149	1249	41	52
AVERAGE	1924	84		15245		8606	602	76	642	39	26

TABLE 5-7f

YUKON HOUSING RENTAL UNITS: DAWSON CITY
SOURCE: YTG Energy Branch, Yukon Housing Corporation

BUILDING	YEAR BUILT	VOLUME M3	80-81 LITRES	MJ/DDY	81-82 LITRES	MJ/DDY	81-82 KWH	AVG YR GJ	KJ/M3 /DDY	RPI	******
DAWSON DEGREE DAYS				6478		8594		8409			
modular double wide	72	266			4567	21	15544	177	79	14	**
exposed floor	72	266			5648	26	16245	218	98	21	***
	72	266			3532	16		137	61	8	*
	76	266			2897	13		112	50	6	
	76	266			1607	7		59	26	2	
	76	266			3414	16		132	59	8	*
	76	266			2279	10		88	39	3	
AVERAGE		266			3421	16	15895	132	59	8	*
3 bedroom detached	72	212	4290	26	4467	21	8054	196	110	22	***
exposed floor		212	4077	25	3773	17	10300	177	100	18	**
		212	3568	22	4195	19	11054	173	97	17	**
		212	4308	26	4145	19	9572	191	107	20	***
		212	4331	26	4926	23	13047	206	116	24	***
		212	4109	25	4104	19	8447	185	104	19	**
		212	3528	22	3655	17	12430	161	90	15	**
		212	3618	22	4259	20	26536	175	98	17	**
		212	4054	25	4563	21	12442	192	108	21	***
		212	3941	24	3927	18	13439	177	99	18	**
		212	3759	23	4136	19	11839	176	99	17	**
		212	3382	21	3723	17	15733	159	89	14	**
		212	4063	25	3668	17	15536	175	98	17	**
		212	4150	25	3369	15	14215	171	96	16	**
		212	4091	25	4268	20	7344	187	105	20	***
		212	3437	21	3691	17	14052	159	89	14	**
		212	4758	29	4458	20	10948	208	117	24	***
		212	3904	24	4708	22	8279	191	107	20	***
AVERAGE		212	3965	24	4113	19	12404	181	102	18	**

TABLE 5-7f (cont'd)

YUKON HOUSING RENTAL UNITS: DAWSON CITY
SOURCE: YTG Energy Branch, Yukon Housing Corporation

BUILDING	YEAR BUILT	VOLUME M3	80-81 LITRES	MJ/DDY	81-82 LITRES	MJ/DDY	81-82 KWH	AVG YR GJ	KJ/M3 /DDY	RPI ******
DAWSON DEGREE DAYS				6478		8594		8409		
3 bdrm. duplex	72	234	3641	22	4327	20	13409	177	90	16 **
exposed floor		234	3587	22	2946	14	16262	149	76	11 *
		234	4440	27	4136	19	17502	194	98	19 **
		234	3618	22	3432	16	13228	159	81	13 *
		234	5375	33	3605	17	8659	207	105	22 ***
		234	4018	24	3700	17	9834	175	89	15 **
		234	5176	32	3995	18	9971	210	107	22 ***
		234	3909	24	4032	19	11332	178	90	16 **
		234	3827	23	4000	18	12680	175	89	16 **
		234	3464	21	3782	17	8170	162	82	13 **
		234	2819	17	3868	18	12060	147	75	11 *
		234	3033	18	3296	15	13663	141	72	10 *
AVERAGE		234	3909	24	3760	17	12231	173	88	15 **
3 bdrm. Duplex		351	3242	20	3632	17	12602	153	52	8 *
w/ concrete bsmt		351	3128	19	3641	17	8406	151	51	8 *
		351	3414	21	3287	15	11021	151	51	8 *
		351	3078	19	3074	14	23333	138	47	6 *
		351	3396	21	4663	21	11446	177	60	11 *
		351	3614	22	3995	18	12349	170	58	10 *
AVERAGE		351	3312	20	3715	17	13193	157	53	8 *
TOTAL AVERAGE		248	3829	23	3838	18	12731	167	83	14 *
Teacherge duplex		272			11760	54		455	199	90 ******
Korbo Apts	73	10140	50562	308	46453	214	30974	2194	26	56 ******

TABLE 5-7g

GOVERNMENT OF CANADA HEATING ASSISTANCE PAYMENTS: DAWSON CITY
SOURCE:YTG Dept. of Finance
PERIOD:1 Ap82-31 Mr83 MAX $/LITRE: .49

TYPE	AREA	VOLUME M3	PERIOD	LITRES	GJ	MJ/M3	AVG YR-GJ	KJ/M3 /DDY	RPI *******
DAWSON		DDY50-80=	8409		DDY82-83=	7446			
YHC5	10140	2299	8204.8303	41803	1651	718	1865	96	180 ********
YHC,	1200	272	8205.8303	2023	80	294	90	39	4
RFED	624	141	8209.8303	2297	91	641	102	86	9 *
RDAW	1500	340	8204.8303	1894	75	220	84	30	2
RPVT	275	62	8210.8303	1357	54	860	61	115	7 *
RPVT	2000	453	8211.8303	2580	102	225	115	30	3
RPVT	768	174	8211.8212	550	22	125	65	45	3
RPVT	1000	227	8211.8303	2890	114	504	129	68	9 *
RPVT	1152	261	8210.8302	3946	156	597	176	80	14 **
CHUR	1711	388	8204.8301	8314	328	847	371	114	42 ******
PVT,	800	181	8204.8302	2412	95	525	108	71	8 *
PVT,	1200	272	8210.8303	2685	106	390	120	52	6
PVT,	1100	249	8210.8302	3648	144	578	163	78	13 *
PVT,	970	220	8210.8302	3088	122	555	138	74	10 *
PVT,	800	181	8208.8301	2783	110	606	124	81	10 *
PVT,	1500	340	8210.8303	4510	178	524	201	70	14 **
PVT,	2200	499	8205.8303	7166	283	568	320	76	24 ***
PVT,	1280	290	8204.8303	5391	213	734	240	99	24 ***
PVT,	1500	340	8209.8303	7089	280	823	316	111	35 *****
PVT,	1216	276	8210.8302	2387	94	342	106	46	5
PVT,	1000	227	8210.8303	3675	145	640	164	86	14 **
PVT,	660	150	8204.8303	4591	181	1212	205	163	33 *****
PVT,	1120	254	8210.8303	3371	133	524	150	70	11 *
PVT,	1700	385	8209.8303	6036	238	619	269	83	22 ***
PVT,	1500	340	8204.8303	2221	88	258	99	35	3
PVT,	960	218	8208.8303	4174	165	758	186	102	19 **
PVT,	1240	281	8209.8303	2123	84	298	95	40	4
PVT,	768	174	8204.8302	4318	171	980	193	132	25 ***
PVT,	850	193	8210.8303	2076	82	426	93	57	5
PVT,	800	181	8210.8303	3387	134	738	151	99	15 **
PVT,	880	200	8204.8303	3528	139	699	157	94	15 **
PVT,	720	163	8204.8212	1944	77	470	87	63	5
PVT,	1250	283	8204.8303	6312	249	880	282	118	33 *****

TABLE 5-7g (cont'd)

GOVERNMENT OF CANADA HEATING ASSISTANCE PAYMENTS: DAWSON CITY
SOURCE:YTG Dept. of Finance
PERIOD:1 Ap82-31 Mr83 MAX $/LITRE: .49

TYPE	AREA	VOLUME M3	PERIOD	LITRES	GJ	MJ/M3	AVG YR GJ	KJ/M3 /DDY	RPI *******
DAWSON		DDY50-80=	8409		DDY82-83=	7446			
PVT,	750	170	8204.8303	4223	167	981	188	132	25 ***
PVT,	760	172	8209.8303	3912	155	897	175	120	21 ***
PVT,	1200	272	8209.8303	5214	206	757	233	102	24 ***
PVT,	980	222	8210.8304	3452	136	614	154	82	13 *
PVT,	1200	272	8210.8302	1884	74	274	84	37	3
PVT,	2400	544	8210.8304	3096	122	225	138	30	4
PVT,	996	226	8209.8303	753	30	132	34	18	1
PVT,	800	181	8210.8301	1041	41	227	46	30	1
PVT,	1000	227	8210.8303	5076	201	884	226	119	27 ****
PVT,	960	218	8209.8303	4339	171	787	194	106	20 ***
PVT,	816	185	8210.8303	4179	165	892	186	120	22 ***
PVT,	1000	227	830315	622	25	108	57	30	2
PVT,	600	136	8211.8302	1642	65	477	73	64	5
PVT,	729	165	8210.8304	4400	174	1052	196	141	28 ****
PVT,	2500	567	8210.8303	3732	147	260	166	35	6
PVT,	900	204	8210.8303	3486	138	675	156	91	14 **
PVT,	6700	1519	8206.8304	3503	138	91	156	12	2
PVT,	900	204	8210.8302	2400	95	465	107	62	7 *
PVT,	900	204	8204.8303	4808	190	931	214	125	27 ****
PVT,	600	136	8204.8303	2836	112	824	127	111	14 **
PVT,	960	218	8209.8302	3868	153	702	173	94	16 **
PVT,	924	209	8210.8304	3063	121	578	137	78	11 *
PVT,	300	68	8210.8303	1884	74	1094	84	147	12 *
PVT,	600	136	821013	718	28	208	32	28	1
PVT,	910	206	8210.8304	4690	185	898	209	121	25 ***
PVT,	700	159	8209.8303	2744	108	683	122	92	11 *
PVT,	792	180	8210.8303	4071	161	896	182	120	22 ***
PVT,	1080	245	8211.8304	4782	189	771	213	104	22 ***
PVT,	880	200	8210.8304	2931	116	580	131	78	10 *
PVT,	792	180	8211.8304	2385	94	525	106	70	7 *
PVT,	621	141	8210.8304	2902	115	814	129	109	14 **
AVG	1135	257		3387	134	599	152	81	14 **

5.3 MINING COMMUNITIES

Four communities are included in this group, one on the Pelly River and three in the area of Stewart River.

5.3.1 Faro

5.3.1.1 Cultural and Economic Setting

Faro was developed in 1969 by Cyprus Anvil Mining Corporation. With 1,700 inhabitants it is the second largest community in the Yukon and houses the employees of the Cyprus Anvil lead-zinc mining operation. Faro was destroyed by forest fire during construction, but was rebuilt within three months. In 1972 it was incorporated with 'town' status, which is unique in Yukon Territory. Concentrates from the open pit mine are shipped by White Pass trucks, rail and ships to markets primarily in Japan and West Germany.

5.3.1.2 Community Energy Planning for Faro

If the community of Faro wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Faro.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Faro, then the estimated space heating load of 120000 Gigajoules could be reduced by 50 percent to 60000 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Faro, the other sector which uses a large proportional amount of energy for space heating is the Commercial sector. Commercial buildings consume 20 percent of the space heating fuel and comprise only 9 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public buildings will offer the most favorable conservation/ retrofit opportunities.

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementation of energy conservation. People from communities

TABLE 5-8

COMMUNITY ENERGY PROFILE: FARO POPULATION: 1700

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL FUEL GJ	%	TOTAL GJ	%
FED GOVERNMENT	7	1	51	358	2	322	2255	2	3544	2
YUKON & MUNICPL GOVT	7	1	51	358	2	400	2800	2	4089	2
EDUCATION	1	0	607	607	4	6695	6695	6	8877	5
COMMERCIAL	51	9	59	3000	20	470	23981	20	34772	20
FED GOVT RESIDENTIAL	7	1	18	126	1	140	980	1	1433	1
YUKON HSG CORP	19	3	16	304	2	140	2660	2	3754	2
RESIDENTIAL	504	85	20	10030	68	160	80640	67	116718	67
TOTAL	596			14783			120011		173187	
			GRID			GJ USED PERCAPITA:			102	
INDUSTRIAL				125000		FUEL OIL	21968		621608	
						COAL	150000			

throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to energy conservation. Beginning in 1984, Yukon College, through the Education Extension Program will offer courses in Faro for those who are interest in retrofit technology, energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved. This will result in reductions of oil use, both through direct space heating and energy requirements for fuel transport. Residential buildings sampled in Faro for this study, indicate retrofit potential indices (RPI) as high as 14. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in Faro and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load ranges from 140 to 160 Gigajoules per household. The lower figure undoubtably reflects seasonal occupation of the houses and/or the utilization of wood as a supplementary heating fuel. The upper figure represents totally wood heated households. Three factors contribute to this high value. Firstly, the typical inefficiency of most wood burning appliances, secondly, the inaccuracy of estimated "cord" value, and thirdly, the residences which use wood as the primary heating source are generally less thermally efficient than other residences in the community.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

Since Faro is connected to the hydroelectric power grid, electricity is an available renewable resource which could be used for space heating. However, since electricity supplies higher grade energy requirements which cannot be feasibly provided by fuel, then it may be more prudent to utilize electricity to sustain the desired level of economic development, than to use it as an alternative source for space heating. Only those buildings which meet the recommendations for the upcoming Northern Building

Energy Standards (NRC-DBR) can be considered as viable candidates for electrical space heating.

Another renewable energy supply option which would be more favorable than hydro-electric power for space heating in Faro is the efficient utilization of wood as a space heating fuel, and a well organized fuel wood delivery system.

Other energy supply options for Faro are discussed in the following sections.

5.3.1.3 Energy Supply Options

The central feature of the Faro energy profile is the dominance of the Cyprus Anvil Mine. Assuming it goes back into operation, the Whitehorse to Faro grid will be operating near capacity and oil consumption, as the main source of space heating in the town will increase dramatically, in which case additional electric power as well as energy substitutes for space heat could be well justified.

(a) Wood

Faro lies in the middle of a sizeable fire-killed forest area estimated at approximately 50,000 hectares. If the mine does not return to using coal to fire its space heat and ore drying furnaces, chipped wood would certainly be a feasible alternative. If sufficient steam is raised in these operations, cogeneration of electricity could also be contemplated. This could remove the need for diesels for peak shaving and load stabilization and free up more energy on the grid.

In its last full year of operation, the mine used 20,000 tons of coal for these processes. This is approximately 400,000 GJ of energy. The equivalent quantity of wood for this use would be a little more than 56,000 cubic meters. At an estimated stand density of 100 cubic meters per hectare, the area around Faro could supply the mine for over 50 years.

Live stands in the area are also reported to be of relatively high density, suggesting even larger total resource.

Wood use in the town is quite low, probably due to collective bargaining agreements in which the mine compensates its employees for oil use. Wood is readily available for use in wood burning stoves and furnaces in individual residences and commercial buildings. Wood-fired boilers would be appropriate for larger buildings with hydronic heating systems.

Possibly the greatest impediment to reducing oil consumption in Faro is the combination of government and mine institutional factors which actually have the effect of encouraging oil consumption, despite the fact that the town sits in the midst of a sizeable quantity of ready to use wood.

(b) Coal

Coal has been used in the past by Cyprus Anvil for space heating and ore drying. If the mine commences operations again, a new source of coal must be developed. Certainly, coal should be used for these purposes in the future if wood cannot be used as a substitute.

It may be possible to use coal for some heating purposes in the town as well, much as wood would be used.

(c) Hydro

When the mine is operating, more power could be used, therefore potential sites for small hydro suitable for the community were investigated. Large scale hydro suitable for the mine demands were not sought.

One site, on Lapie River, indicating some potential is about 56 km southeast of Faro, near Ross River. The indicated potential is about 7 MW, which would be sufficient to supply both Faro and Ross River.

The key question with respect to any hydro in this area, as well as any cogeneration at the mine, is whether the new generating capacity would be less expensive than the next hydro project on the central grid. Since Faro is already on the grid, more capacity anywhere else on the grid would allow the substitution of oil heating with electric heating at this section. See the general comments on hydro capacity and small hydro development in Section 5.1.2.

5.3.1.4 Energy Use Data Tables for Faro

TABLE 5-9a

YTG & MUNICIPAL BUILDINGS ENERGY USE: FARO
SOURCE: YTG Energy Branch, YTG Supply Services Branch, YECL

#	DESCRIPTION	83-4 FUEL EST LTR*1000	82-3 ELEC MWH	82-3 FUEL LITRES	81-2 ELEC MWH	81-2 FUEL GAL	80-1 ELEC MWH	80-1 FUEL GAL
706	Van Gorder School	170	619	231829	684	57869	519	27741
	Liquor Store							
M	Town office							
M	Arena							
M	Main Shop							
M	Airport term bldg							
M	Water supply, 3 pumps							
M	Animal Shelter							
	Tfk & St Lights		71		71		71	
	TOTAL	170	690	231829	755	57869	590	27741

MUNICIPAL GOVT BUILDINGS: 6

BAND COUNCIL BUILDINGS:

#	DESCRIPTION	80-1 ELEC GJ	81-2 ELEC GJ	82-3 ELEC GJ	AVG 80-3 ELEC GJ	80-1 FUEL GJ	81-2 FUEL GJ	82-3 FUEL GJ	AVG 80-3 FUEL GJ	AVG FUEL GJ	EST 83-4 FUEL GJ
706	Van Gorder School	1867	2462	2227	2185	4975	10378	9157	8170	7433	6695
	Liquor Store										
M	Town office										
M	Arena										
M	Main Shop										
M	Airport term bldg										
M	Water supply, 3 pump										
M	Animal Shelter										
	Tfk & St Lights	256	256	256	256						
	TOTAL				2441				8170	7433	6695

TABLE 5-9b

GOVERNMENT FUEL REQUIREMENTS ESTIMATES - 1983-84
SOURCE: YTG Supply & Services, Fed. Govt. Supply & Services
Data in Litres X 1000

Community	YTG Bldgs	Education	Fed. Govt.	F.G. Res.
Faro		170	18 46	18
Total Litres:		170	64	18
Total # bldgs		1	7	7
GJ:		6695	2508	711
Total Govt.:	2508			
GJ per Bldg.:		6695	358	102

TABLE 5-9c

RCMP BUILDINGS - ENERGY USE: FARO
SOURCE - RCMP, Whitehorse

DESCRIPTION	VOL (M3)	81-82 LITRES	MJ/DDY	82-83 LITRES	MJ/DDY	82-83 MWH	AVG YR GJ	KJ/M3 /DDY	RPI	83-4 FUEL EST litres	GJ
FARO		DDY=	8238	DDY=	8238		7634				
stn. residence	266	1399	7	4318	21	14	105	51	5	36400	1438
cell block	266	2386	11	1882	9	4.3	78	38	3		
garage	266	2248	11	393	2	1.9	48	24	1		
418 Campbell	372	2839	14	1974	9	22	88	31	3		
412 Campbell	372	5743	28	4581	22	11	189	67	13		
132 Dawson	252	2329	11	1962	9	15	79	41	3		
AVERAGE	299	2824	14	2518	12	11	98	42	5		
TOTAL	1794	16944	81	15110	72	68.2	587	43		36400	1438 2.45

TABLE 5-9d

COMMERCIAL BUILDING ENERGY USE: FARO
SOURCE: YTG Energy Branch Commercial Energy Audits

BUILDING	VOLUME M3	ELEC MWH	PERIOD	FUEL LITRES	PERIOD	DDY	FUEL GJ	MJ/M3	AVG YR GJ	KJ/M3 /DDY	RPI
									7634		
TRANSPORT Vangords	2012	37	yrly est	26099	04.104	6918	1031	512	1138	74	84

TABLE 5-9e

COMMERCIAL ELECTRICITY: FARO
SOURCE:YTG Econ Devt Branch
Yukon Business Directory, NorthwesTel Directory

82-83 MWH	ELEC GJ	$/MWH	#	IC
			3	J64
			1	Q91
			2	J60
			1	D61
			1	D92
			9	R98
			2	R99
			5	R96
			2	R97
			5	G45
			2	J63
			4	J65
			4	P86
			1	A21
			1	K70
			2	F42
			1	D61
			1	E28
			1	M77
			2	H48
			1	G49

AVG MWH

AVG $/MWH

TOTAL MWH

OTHER COM 51

TOTAL COM 51

TABLE 5-9f

YUKON HOUSING RENTAL UNITS: FARO
SOURCE: YTG Energy Branch, Yukon Housing Corp

BUILDING	YEAR	VOLUME M3	80-81 LITRES	MJ/DDY	81-82 LITRES	MJ/DDY	81-82 ELEC KWH	AVG YR GJ	KJ/M3 /DDY	RPI	*******
FARO				6918		8238		7634			
2 bdrm. mobile	83	150	2542	15	1989	10		92	80	7	*
	83	150	3696	21	2942	14		134	118	16	**
AVERAGE		150	3119	18	2465	12		113	99	11	*
modular dbl. wide	75	375	2783	16	2756	13		111	39	4	
	75	375	2670	15	2479	12		104	36	4	
	75	375	2906	17	2624	13		111	39	4	
	75	375	1930	11	2152	10		81	28	2	
	75	375	1689	10	2365	11		80	28	2	
	75	375	2166	12	2393	11		91	32	3	
	75	375	1462	8	1634	8		62	22	1	
	75	375	1539	9	2915	14		87	30	3	
AVERAGE		375	2143	12	2415	12		91	32	3	
3 bdrm. mobile	72	220	3714	21	3696	18		149	89	13	**
	72	220	2497	14	2306	11		97	58	6	
	76	220	4372	25	3078	15		152	90	14	**
	76	220	2397	14	2238	11		93	56	5	
	76	220	3814	22	3537	17		148	88	13	**
	76	220	3273	19	3478	17		135	81	11	*
	76	220	4367	25	3223	15		154	92	14	**
	76	220	2710	15	1907	9		94	56	5	
AVERAGE		220	3393	19	2933	14		128	76	10	*
3 bdrm. detatched		212	3446	20	863	4		91	56	5	
TOTAL AVERAGE		273	2847	16	2563	12		109	60	7	*

TABLE 5-9g

PARC HOUSING UNITS
[illegible]
Data from 81-82

Type of Unit	#	Volume m3	ELECTRICITY kWh low	mean	high	Total MWh	FUEL OIL litres low	mean	high	Total litres	mts GJ	MJ/M3	KJ/M3 /DD
1-Bedroom apt	15	125		14130		212							
2-Bedroom apt	32	174		14130		452							
2-M Row	25	304	8678	12136	15534	303	2124	3259	4334	31475	129	423	52
3-M Row	43	330	8635	14427	20219	520	2732	3949	5166	159807	156	463	58
Duplex	40	403	9734	15095	20456	504	3208	4051	4894	162048	160	331	48
K Row	30	389	9179	14393	19553	432	2723	3153	3583	94630	125	321	39
N Row	73	342	8044	12250	16456	894	2535	3269	4003	238637	129	377	46
R Row	14	423	9164	14015	18866	196	2793	3420	4047	47880	135	315	39
J Row	6	463	7242	13035	18830	78	3022	3863	4704	23178	157	330	41
F Row End	10	541	14761	18732	22323	188	3643	4442	5241	44428	175	324	40
Single Wide	26	174	9125	12207	15288	317	2807	3463	4119	90038	137	786	97
Double Wide	20	300	10086	14950	19814	299	4062	4898	5734	97960	193	646	79
OOA SFD 69	15	609	13210	23440	33670	352	4622	5411	6200	81165	214	351	43
OB1 SFD 69	1	560		22772		23		4955		4955	196	297	37
B1B SFD 69	4	634	17463	19849	22235	80	4880	6225	7570	24900	246	388	48
OB2 SFD 69	6	609	15360	19616	23872	118	5252	6352	7452	38112	251	412	51
B1U SFD 69	2	660	16404	19231	22058	38	5011	6225	7439	12450	245	373	46
BU2 SFD 69	1	634		31579		32		5417		5417	214	337	42
C SFD 69	1	542		18835		19		6897		6897	272	503	62
E SFD	10	602	15823	21040	26257	210	3456	4406	5356	44060	174	289	36
T1 SFD 80	7	542	14137	21818	29499	153	2586	3172	3758	22204	125	231	28
T2 SFD 80	7	584	22566	33323	44080	233	3358	3762	4166	26334	149	255	31
T3 SFD 80	20	506	19105	21295	23485	426	3245	3971	4697	79420	157	310	38
T4 SFD 80	6	449	22271	30489	38707	183	2421	2884	3347	17304	114	254	31
T5 SFD 80	7	541	15541	23635	31729	165	3287	3645	4003	25515	144	266	33
T6 SFD 80	6	489	15642	26346	37050	158	2417	2845	3273	17070	112	208	28
T7 SFD 80	13	437	11793	20875	29957	271	3763	4541	5319	62933	131	385	47
T8 SFD 80	14	528	14822	22033	29244	308	3815	4239	4663	59346	167	317	33
TOTAL	455					7320				1578137			
AVERAGE		491	13102	19304	25534		3424	4047	4901		172	368	45

TABLE 5- 9h

GOVERNMENT OF CANADA HEATING ASSISTANCE PAYMENTS: FARO
SOURCE:YTG Dept. of Finance
PERIOD:1 Ap82-31 Mr83 MAX $/LITRE: .447

TYPE	AREA	VOLUME M3	PERIOD	LITRES	GJ	MJ/DDY	AVG YR GJ	KJ/M3 /DDY	RPI *******
FARO		DDY50-80=	7634		DDY82-83=	7655			
YHC7	900	204	205.303	3160	125	16	124	80	10 *
YHC7	900	204	204.303	3791	150	20	149	96	14 **
YHC6	1300	295	204.303	2335	92	12	92	41	4
YHC6	1300	295	204.303	3406	135	18	134	60	8 *
YHC6	2400	544	209.303	3106	123	16	122	29	4
RCAM	1344	305	211.303	2211	87	11	87	37	3
PVT,	600	136	204.303	2384	94	12	94	90	8 *
PVT,	600	136	204.302	2029	80	10	80	77	6
PVT,	864	196	204.303	2466	97	13	97	65	6
PVT,	1300	295	204.301	1792	71	9	71	31	2
AVER	1300	295		1792	71	9	71	31	2

5.3.2 Mayo

5.3.2.1 Cultural and Economic Setting

The Mayo area, considered a fur-rich area in pre-Gold Rush Days, was first settled in 1903 to provide a focus for gold exploration. A decade later, when silver-lead ore was found at Elsa, Keno and other mines, Mayo began to function as a distribution and service center, which it still is to date. However, with the building of the road in the 1950's, Mayo became less important as a port than as a base for prospecting (Bonnet Plume area). At present, 25% of the population of 500 are Natives.

5.3.2.2 Community Energy Planning for Mayo

If the community of Mayo wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Mayo.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Mayo, then the estimated space heating load of 49000 Gigajoules could be reduced by 50 percent to 24500 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Mayo, the other sector which uses a large proportional amount of energy for space heating is the Yukon and Municipal Government sector. Yukon and Municipal Government buildings consume 11 percent of the space heating fuel and comprise only 7 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public buildings will offer the most favorable conservation/ retrofit opportunities.

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementation of energy conservation. People from communities throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to energy conservation. Beginning in 1984, Yukon College, through the Education Extension Program will offer courses in Mayo for those who are interest in retrofit technology,

TABLE 5-10

COMMUNITY ENERGY PROFILE: MAYO POPULATION: 500

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL SPHT GJ	%	TOTAL GJ	%
FED GOVERNMENT	28	11	20	560	14	287	8022	16	10036	16
YUKON & MUNICPL GOVT	18	7	20	360	9	300	5400	11	6695	11
EDUCATION	1	0	220	220	6	5728	5728	12	6519	10
COMMERCIAL	28	11	20	560	14	200	5600	11	7614	12
FED GOVT RESIDENTIAL	14	6	20	280	7	160	2240	5	3247	5
YUKON HSG CORP	28	11	14	392	10	166	4648	9	6058	10
RESIDENTIAL	77	31	12	950	24	110	8470	17	11886	19
RESIDENTIAL (ttl wd)	55	22	12	678	17	168	9240	19	11680	18
TOTAL	249			4000			49348		63736	
TOTAL RESIDENTIAL	174			2300						

GJ USED PERCAPITA 127

kWh/litre gen eff:GRID 0 GJ

TOTAL GJ INPUT: 63736

GJ INPUT PERCAPITA 127

energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved. This will result in reductions of oil use, both through direct space heating and energy requirements for fuel transport. Residential buildings sampled in Mayo for this study, indicate retrofit potential indices (RPI) as high as 24. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in Mayo and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load ranges from 110 to 168 Gigajoules per household. The lower figure undoubtably reflects seasonal occupation of the houses and/or the utilization of wood as a supplementary heating fuel. The upper figure represents totally wood heated households. Three factors contribute to this high value. Firstly, the typical inefficiency of most wood burning appliances, secondly, the inaccuracy of estimated "cord" value, and thirdly, the residences which use wood as the primary heating source are generally less thermally efficient than other residences in the community.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

Since Mayo is connected to the hydroelectric power grid, electricity is an available renewable resource which could be used for space heating. However, since electricity supplies higher grade energy requirements which cannot be feasibly provided by fuel, then it may be more prudent to utilize electricity to sustain the desired level of economic development, than to use it as an alternative source for space heating. Only those buildings which meet the recommendations for the upcoming Northern Building Energy Standards (NRC-DBR) can be considered as viable candidates for electrical space heating.

Another renewable energy supply option which would be more favorable than hydro-electric power for space heating in Mayo is the efficient utilization of wood as a space

heating fuel, and a well organized fuel wood delivery system.

Other energy supply options for Mayo are discussed in the following sections.

5.3.2.3 Energy Supply Alternatives

(a) Hydro

Mayo already enjoys the lowest cost electricity in the Yukon. However, with the potential demand from United Keno Hill Mines assumed in the load, the Mayo system is near capacity. Without the mine load, the best off-oil alternative after conservation would be to convert all space heating to electric. A potential site for additional hydro capacity has been studied by NCPC downstream of the existing power station. This site reportedly raises some environmental problems however. Refer to the general comments on small hydro development in Section 5.1.2.

(b) Grid Extension

The nearest access to the central grid is at Carmacks, about 160 km as the crow flies to the south. Certainly, a grid extension over this distance would not be contemplated for Mayo alone. However, such an extension would include Elsa and Keno since they are already on the Mayo grid. In addition, the suitable routing could include Pelly Crossing and Stewart Crossing enroute.

Such a grid extension would possibly be less costly than the development of individual off-oil alternatives in all of these communities. Insufficient capacity on the combined central and Mayo grids to satisfy the load, could trigger a more economical scheme elsewhere on the grid. See the comments on grid capacity in Section 5.1.2.

(c) Wood

There is a small fire killed area north of Mayo along the highway to Elsa. Burned in 1971, this area is reported to be near depletion. However, a larger area of 6,883 hectares of high density stands about 20 kilometers east of Mayo but no roads go into the area, although a dirt track to Janet Lake goes within about 2 kilometers of the burn area, however.) This area could represent a substantial resource for space heating in the town and for ore drying at the mines at Elsa.

If electric power in Mayo becomes no longer abundant, wood use should definitely be encouraged and larger institutional buildings should be considered for wood-fired hydronic systems similar to those at Pelly Crossing. See Section 5.1.2 for general comments on wood use.

5.3.2.4 Energy Use Data Tables for Mayo

TABLE 5-11a

YTG & MUNICIPAL BUILDINGS ENERGY USE: MAYO
SOURCE: YTG Energy Branch, YTG Supply Services Branch, YECL

#	DESCRIPTION	83-4 FUEL EST LTR*1000	82-3 ELEC MWH	82-3 FUEL LITRES	81-2 ELEC MWH	81-2 FUEL GAL	80-1 ELEC MWH	80-1 FUEL GAL
623	J.V.Clark School	145	221	128296	210	39571	227	26831
629	Grader Station	25				5797		5553
628	Liqr Str,Firehl				23	3723	20	3729
630	Wrhse,garage							
639	Social Welfr Ofc							
640	Bldg Maint Shop	5				1982		1265
642	Fuel Disp Bldg							
648	Admin Bldg	50						
650	Wldlife Br gar	9						
M	Firehall			4856				
M	Community Hall			7873				
M	Curling Rink			9950				
	Tfk & St Lights		32		32		33	
	TOTAL	234	253	150975	265	51073	280	37378

MUNICIPAL GOVT BUILDINGS: 9...grp hm,mobl trlr,anml shltr,pmphse,wrhse,sewr pmp,ind gar

BAND COUNCIL BUILDINGS: 5...band office (X3),seniors hm,warehouse

#	DESCRIPTION	80-1 ELEC GJ	81-2 ELEC GJ	82-3 ELEC GJ	AVG 80-3 ELEC GJ	80-1 FUEL GJ	81-2 FUEL GJ	82-3 FUEL GJ	AVG 80-3 FUEL GJ	AVG FUEL GJ	EST 83-4 FUEL GJ
623	J.V.Clark School	817	757	797	790	4812	7096	5068	5659	5693	5728
629	Grader Station					996	1040		1018	1003	988
628	Liqr Str,Firehl	71	81		76	669	668		668	668	
630	Wrhse,garage										
639	Social Welfr Ofc										
640	Bldg Maint Shop					227	355		291	244	198
642	Fuel Disp Bldg										
648	Admin Bldg									1975	1975
650	Wldlife Br gar									356	356
M	Firehall							192	192	192	
M	Community Hall							311	311	311	
M	Curling Rink							393	393	393	
	Tfk & St Lights	119	115	115	116						
	TOTAL				983				8531	10834	9243
	AVG w/o school, grader stn, st lights			MWH:	21			GJ:	371	591	843

TABLE 5-11b

GOVERNMENT FUEL REQUIREMENTS ESTIMATES - 1983-84
SOURCE: YTG Supply & Services, Fed. Govt. Supply & Services
Data in Litres X 1000

Community	YTG Bldgs	Education	Fed. Govt.	F.G. Res.
Mayo	50	145	84	7
	5		38	7
	25		81	7
	9			7
				7
				49
Total Litres:	89	145	203	84
Total # bldgs	7	1	28	14
GJ:	3516	5728	9022	3319
Total Govt.:	11538			
GJ per Bldg.:	502	5728	287	237

TABLE 5-11c

RCMP BUILDINGS - ENERGY USE: MAYO
SOURCE - RCMP, Whitehorse

DESCRIPTION	VOL (M3)	81-82 LITRES	MJ/DDY	82-83 LITRES	MJ/DDY	82-83 MWH	AVG YR GJ	KJ/M3 /DDY	RPI	83-4 FUEL EST litres	GJ
MAYO		DDY=	8236	DDY=	7771		8022				
trailer	248	3088	15	2377	12	11	108	54	6		
detach/qtrs	934	13177	63	10731	55	47	472	63	30	36400	1438
DW 1978	248	2544	12	2506	13	21	100	50	5		
AVERAGE	477	6270	30	5205	26	26	227	59	14		
TOTAL	1431	18809	90	15614	79	78	680	59		36400	1438 2.11

TABLE 5-11d

COMMERCIAL ELECTRICITY: MAYO
SOURCE:YTG Econ Devt Branch
Yukon Business Directory, NorthwesTel Directory

	82-83 MWH	ELEC GJ	$/MWH	#	IC
STORE	55.08	198	14.3	1	J64
HOTEL	103.44	372	14.4	1	B91
				1	J60
				1	C41
				1	C4
				1	B91
				1	D6
				1	D61
				3	R98
				2	R99
				1	F40
				1	F42
				5	G45
				2	J64
				2	J63
				1	D92
				1	N98
				1	H48
				1	G49

AVG MWH 79.26
AVG $/MWH 14.35
TOTAL MWH 159

OTHER COM 26

TOTAL COM 28

TABLE 5-11e

YUKON HOUSING RENTAL UNITS: MAYO
SOURCE: YTG Energy Branch, Yukon Housing Corp

BUILDING	YEAR	VOLUME M3	80-81 LITRES	MJ/DDY	81-82 LITRES	MJ/DDY	81-82 ELEC KWH	AVG YR GJ	KJ/M3 /DDY	RPI *******
MAYO				6933		8236		8022		
senior's fourplex	79	840	9121	52	8390	40	20914	370	55	20 ***
duplex	72	286	4104	23	3582	17	6528	163	71	12 *
	72	296	3387	19	3519	17	5847	145	63	9 *
	72	286	4772	27	4286	21	10447	191	83	16 **
	72	286	4654	27	3251	16	3593	169	74	12 *
	72	286	4758	27	3573	17	4062	177	77	14 **
	72	286	3773	21	4349	21	11498	170	74	13 *
	72	296	4635	26	4440	21	12759	191	83	16 **
	72	286	4522	26	4272	20	6607	186	81	15 **
	72	286	3923	22	2738	13	6113	142	62	9 *
	72	286	4649	26	4027	19	6998	184	80	15 **
AVERAGE		286	4318	25	3804	18	7445	172	75	13 **
bilevel split entry	75	355	3832	22	3478	17	12469	154	54	8 *
	75	355	3764	21	3587	17	5539	155	54	8 *
	75	355	3505	20	3968	19	6346	156	55	9 *
	75	355	3505	20	3932	19	11296	156	55	9 *
	75	355	3746	21	3836	18	5288	159	56	9 *
	75	355	3655	21	3909	19	7325	159	56	9 *
	75	355	3210	18	4209	20	20267	154	54	8 *
	75	355	3387	19	3441	17	5877	144	50	7 *
	75	355	3528	20	3864	19	12881	155	54	8 *
	75	355	3814	22	4622	22	13599	176	62	11 *
	75	355	3768	21	3346	16	14006	150	53	8 *
	75	355	4032	23	4295	21	15816	175	61	11 *
	75	355	3677	21	2810	13	1940	138	49	7 *
	75	355	3768	21	4254	20	12643	168	59	10 *
AVERAGE		355	3656	21	3825	18	10378	157	55	9 *
TOTAL AVERAGE		326	3936	22	3816	18	9137	166	64	11 *

TABLE 5-11f

GOVERNMENT OF CANADA HEATING ASSISTANCE PAYMENTS: MAYO
SOURCE:YTG Dept. of Finance
PERIOD:1 Ap82-31 Mr83 MAX $/LITRE: .5

TYPE	AREA	VOLUME M3	PERIOD	LITRES	GJ	MJ/M3	AVG YR GJ	KJ/M3 /DDY	RPI *******
MAYO		DDY50-80=	8022		DDY82-83=	7771			
YHC6	1700	385	209.303	3177	125	326	130	42	5
YHC6	1000	227	209.303	3312	131	577	135	74	10 *
RPVT	890	202	209.303	2634	104	516	107	66	7 *
RPVT	1768	401	209.303	3312	131	326	135	42	6
RPVT	1200	272	205.302	3609	143	524	147	67	10 *
RPVT	630	143	210.212	1804	71	499	74	64	5
PVT,	920	209	209.301	1137	45	215	46	28	1
PVT,	720	163	210.303	2067	82	500	84	64	5
PVT,	574	130	209.302	3602	142	1093	147	141	21 ***
PVT,	936	212	211.303	3268	129	608	133	78	10 *
PVT,	800	181	210.302	2727	108	594	111	76	8 *
PVT,	1288	292	210.303	4635	183	627	189	81	15 **
PVT,	1536	348	208.303	3763	149	427	153	55	8 *
PVT,	720	163	211.302	1980	78	479	81	62	5
PVT,	936	212	206.303	4964	196	924	202	119	24 ***
PVT,	1500	340	209.303	3591	142	417	146	54	8 *
AVG	1158	263		2712	107	426	111	55	6

5.3.3 Elsa

5.3.3.1 Cultural and Economic Setting

Elsa is now the main settlement for United Keno Hill Mines Limited (silver-lead-zinc). The town was named after one of the many mining camps in the area. Galena Hill Silver ore was first worked in 1914. However, the settlement did not gain importance until the 1930's when Treadwell Yukon Company moved into Elsa. By 1938 Elsa had a school, hockey rink and a Community Center. By this time the workforce was employed on a year round basis. Currently, there are 336 inhabitants and this population is not expected to change significantly in the future.

5.3.3.2 Community Energy Planning for Elsa

If the community of Elsa wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Elsa.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Elsa, then the estimated space heating load of 27000 Gigajoules could be reduced by 50 percent to 13500 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Elsa, the other sector which uses a large proportional amount of energy for space heating is the Yukon and Municipal Government sector. Yukon and Municipal Government buildings consume 16 percent of the space heating fuel and comprise only 9 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public buildings will offer the most favorable conservation/ retrofit opportunities.

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementation of energy conservation. People from communities throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to energy conservation. Beginning in 1984, Yukon College, through the Education Extension Program will offer courses

TABLE 5-12

COMMUNITY ENERGY PROFILE: ELSA POPULATION: 400

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL SPHT GJ	%	TOTAL GJ	%
FED GOVERNMENT										
YUKON & MUNICPL GOVT	12	9	25	300	10	350	4200	16	5279	14
EDUCATION	1	1	78	78	3	1167	1167	4	1448	4
COMMERCIAL	15	12	32	482	17	350	5250	19	6984	19
FED GOVT RESIDENTIAL										
YUKON HSG CORP	1	1	20	20	1	160	160	1	232	1
RESIDENTIAL	101	78	20	2020	70	160	16160	60	23426	63
RESIDENTIAL (ttl wd)			20							
TOTAL	130			2900			26937		37369	
TOTAL RESIDENTIAL	102			2040		GJ	USED PERCAPITA		93	
INDUSTRIAL				26470		FUEL OIL	112748		207964	
			ELSA TOTAL:	29370			139685			

in Elsa for those who are interest in retrofit technology, energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved. This will result in reductions of oil use, both through direct space heating and energy requirements for fuel transport. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in Elsa and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load is 160 Gigajoules per household. This figure probably reflects intermittent occupation of houses and/or the utilization of wood as a supplementary heating fuel. These data are based on Mayo houses, since only limited data are available for this company town.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

Most houses in Elsa are supplied with heat from the mine through a steam distribution system. The district heating system is in need of repair; the lack of reliability of this system has necessitated the use of small oil-fired furnaces in the houses.

Since Elsa is connected to the hydroelectric power grid, electricity is an available renewable resource which could be used for space heating. However, since electricity supplies higher grade energy requirements which cannot be feasibly provided by fuel, then it may be more prudent to utilize electricity to sustain the desired level of economic development, than to use it as an alternative source for space heating. Only those buildings which meet the recommendations for the upcoming Northern Building Energy Standards (NRC-DBR) can be considered as viable candidates for electrical space heating.

Another renewable energy supply option which would be more favorable than hydro-electric power for space heating in Elsa is the efficient utilization of wood as a space

heating fuel, and a well organized fuel wood delivery system.

Other energy supply options for Elsa are discussed in the following sections.

5.3.1.2 Energy Supply Alternatives

(a) Hydro

Elsa already enjoys the lowest cost electricity in the Yukon. However, with the potential demand from United Keno Hill Mines assumed in the load, the system is near capacity. Without the mine load, the best off-oil alternative would be to convert all space heating to electric. A potential site for additional hydro capacity has been studied by NCPC downstream of the existing power station. This site reportedly raises some environmental problems however. See the general comments on hydro capacity in Section 5.1.2.

(b) Wood

There is a small fire killed area south of Elsa along the highway to Mayo. Burned in 1971, this area is reported to be near depletion. However, a larger area of 5,883 hectares of high density stands about 20 kilometers east of Mayo but no roads go into the area, although a dirt track to Janet Lake goes within about 2 kilometers of the burn area, however.) This area could represent a substantial resource for space heating in the town and for ore drying at the plant at Elsa.

If electric power in Elsa becomes no longer abundant, wood use should definitely be encouraged and larger institutional buildings should be considered for wood-fired hydronic systems similar to those at Pelly Crossing. See Section 5.1.2 for general comments on wood use.

5.3.3.4 Energy Use Data for Elsa

TABLE 5-13

YTG & MUNICIPAL BUILDINGS ENERGY USE: ELSA
SOURCE: YTG Energy Branch, YTG Supply Services Branch, YECL

#	DESCRIPTION	83-4 FUEL EST LTR*1000	82-3 ELEC MWH	82-3 FUEL LITRES	81-2 ELEC MWH	81-2 FUEL GAL	80-1 ELEC MWH	80-1 FUEL GAL
611	School & Teacherage	32	78	24414	67	8977	89	5161
	TOTAL	32	78	24414	67	8977	89	5161

MUNICIPAL GOVT BUILDINGS: Recreation hall, Curling rink, Pool, Firehall, Pumphse/water supply, Sewage lift

BAND COUNCIL BUILDINGS:

#	DESCRIPTION	80-1 ELEC GJ	81-2 ELEC GJ	82-3 ELEC GJ	AVG 80-3 ELEC GJ	80-1 FUEL GJ	81-2 FUEL GJ	82-3 FUEL GJ	AVG 80-3 FUEL GJ	AVG FUEL GJ	EST 83-4 FUEL GJ
	School & Teacherage	321	241	280	281	926	1610	964	1167	1221	1276
	TOTAL				281				1167	1221	1276

5.3.4 Keno

5.3.4.1 Cultural and Economic Setting

Keno is located fourteen kilometers northeast of Elsa. The town was named after the first rich silver-lead producing claim, "The Keno", discovered in 1919. Totally dependent on mineral extraction, Keno suffers periodic depressions (1930's and World War II), which is reflected in population fluctuations. Keno is not a planned community; unlike other mining towns developed by mining companies, it has a haphazard appearance. There are many old unoccupied buildings in poor condition interspersed between occupied dwellings. No significant change to the population of 88 is predicted.

5.3.4.2 Community Energy Planning for Keno

If the community of Keno wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Keno.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Keno, then the estimated space heating load of 8530 Gigajoules could be reduced by 50 percent to 4265 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Keno, the other sector which uses a large proportional amount of energy for space heating is the Commercial sector. Commercial buildings consume 11 percent of the space heating fuel and comprise only 7 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public buildings will offer the most favorable conservation/ retrofit opportunities.

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementation of energy conservation. People from communities throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to energy conservation. Beginning in 1984, Yukon College, through the Education Extension Program will offer courses

TABLE 5-14

COMMUNITY ENERGY PROFILE: KENO POPULATION: 88

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL SPHT GJ	%	TOTAL GJ	%
FED GOVERNMENT										
YUKON & MUNICPL GOVT	3	7	7	21	10	350	1050	11	1126	11
EDUCATION										
COMMERCIAL	3	7	12	36	18	350	1050	11	1179	12
FED GOVT RESIDENTIAL										
YUKON HSG CORP										
RESIDENTIAL	17	36	4	65	32	130	2174	24	2408	24
RESIDENTIAL (ttl wd)	21	46	4	83	40	200	4256	46	4554	46
TOTAL	44			205			8530		9267	
TOTAL RESIDENTIAL	38			148			GJ USED PERCAPITA		105	
	kWh/litre gen eff: GRID				GJ		TOTAL GJ INPUT:		9267	
							GJ INPUT PERCAPITA		105	

in Keno for those who are interest in retrofit technology, energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved. This will result in reductions of oil use, both through direct space heating and energy requirements for fuel transport. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in Keno and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load ranges from 130 to 200 Gigajoules per household. The lower figure undoubtably reflects seasonal occupation of the houses and/or the utilization of wood as a supplementary heating fuel. The upper figure represents totally wood heated households. Three factors contribute to this high value. Firstly, the typical inefficiency of most wood burning appliances, secondly, the inaccuracy of estimated "cord" value, and thirdly, the residences which use wood as the primary heating source are generally less thermally efficient than other residences in the community.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

Since Keno is connected to the hydroelectric power grid, electricity is an available renewable resource which could be used for space heating. However, since electricity supplies higher grade energy requirements which cannot be feasibly provided by fuel, then it may be more prudent to utilize electricity to sustain the desired level of economic development, than to use it as an alternative source for space heating. Only those buildings which meet the recommendations for the upcoming Northern Building Energy Standards (NRC-DBR) can be considered as viable candidates for electrical space heating.

Another renewable energy supply option which would be more favorable than hydro-electric power for space heating in Keno is the efficient utilization of wood as a space

heating fuel, and a well organized fuel wood delivery system.

Other energy supply options for Keno are discussed in the following sections.

5.3.4.3 Energy Supply Alternatives

(a) Hydro

Keno already enjoys the lowest cost electricity in the Yukon. However, with the potential demand from United Keno Hill Mines assumed in the load, the Mayo system is near capacity. Without the mine load, the best off-oil alternative would be to convert all space heating to electric. A potential site for additional hydro capacity has been studied by NCPC downstream of the existing power station at Mayo. This site reportedly raises some environmental problems however. Refer to the general comments on small hydro development in Section 5.1.2.

(c) Wood

There is a small fire killed area south of Keno along the highway to Mayo. Burned in 1971, this area is reported to be near depletion. However, a larger area of 6,883 hectares of high density stands about 20 kilometers east of Mayo but no roads go into the area, although a dirt track to Janet Lake goes within about 2 kilometers of the burn area, however.) This area could represent a substantial resource for space heating in the town.

If electric power in Mayo becomes no longer abundant, wood use should definitely be encouraged and larger institutional buildings should be considered for wood-fired hydronic systems similar to those at Pelly Crossing. See Section 5.1.2 for general comments on wood use.

TABLE 5-15

YTG & MUNICIPAL BUILDINGS ENERGY USE: KENO
SOURCE: YTG Energy Branch, YTG Supply Services Branch, YECL

#	DESCRIPTION	83-4 FUEL EST LTR*1000	82-3 ELEC MWH	82-3 FUEL LITRES	81-2 ELEC MWH	81-2 FUEL GAL	80-1 ELEC MWH	80-1 FUEL GAL
621	Firehall	9	3	11520				
	Street lights		24		22		19	
	TOTAL	9	27	11520	22		19	

MUNICIPAL GOVT BUILDINGS: Recreation hall, Museum, Pumphse/water supply

BAND COUNCIL BUILDINGS:

#	DESCRIPTION	80-1 ELEC GJ	81-2 ELEC GJ	82-3 ELEC GJ	AVG 80-3 ELEC GJ	80-1 FUEL GJ	81-2 FUEL GJ	82-3 FUEL GJ	AVG 80-3 FUEL GJ	AVG FUEL GJ	EST 83-4 FUEL GJ
621	Firehall			11	11			455	455	407	359
	Street lights	67	81	85	77						
	TOTAL				88				455	407	359

5.4 OTHER YUKON COMMUNITIES

These communities are characterized by their locations as service facilities along highways in the Yukon.

5.4.1 Beaver Creek

5.4.1.1 Cultural and Economic Setting

Beaver Creek was first prospected between 1909-1914, and subsequently was used as a supply route to mine claims just over the border (32 km). The present community came into existence with the establishment of the Canada Customs post in 1955; and had a post office by 1958. Beaver Creek also is the center for the YTG Highway Maintenance Yard. During the summer of 1975 a gold rush was predicted for the Beaver Creek area and over 800 claims were staked in the Moosehorn Mountain area.

At present, 20% of the population is Native. The population in general has remained stable over the last 14 years.

5.4.1.2 Community Energy Planning for Beaver Creek

If the community of Beaver Creek wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Beaver Creek.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Beaver Creek, then the estimated space heating load of 17500 Gigajoules could be reduced by 50 percent to 8750 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Beaver Creek, the other sector which uses a large proportional amount of energy for space heating is the Yukon and Municipal Government sector. Yukon and Municipal Government buildings consume 14 percent of the space heating fuel and comprise only 8 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public buildings will offer the most favorable conservation/retrofit opportunities.

TABLE 5-16

COMMUNITY ENERGY PROFILE: BEAVER CREEK POPULATION: 90

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL SPHT GJ	%	TOTAL GJ	%
FED GOVERNMENT	8	9	12	96	10	278	2220	13	2565	12
YUKON & MUNICPL GOVT	7	8	12	84	8	360	2520	14	2822	13
EDUCATION	1	1	22	22	2	660	660	4	738	4
COMMERCIAL	30	34	15	455	46	200	6000	34	7638	36
FED GOVT RESIDENTIAL	14	16	10	140	14	150	2100	12	2604	12
YUKON HSG CORP	6	7	10	60	6	140	840	5	1056	5
RESIDENTIAL	18	20	7	117	12	130	2340	13	2761	13
RESIDENTIAL (ttl wd)	4	5	7	26	3	200	800	5	894	4
TOTAL	88			1000			17480		21077	
TOTAL RESIDENTIAL	42			343						

kWh/litre gen eff: 2.88 13036 GJ

GJ USED PERCAPITA 234

TOTAL GJ INPUT: 30516

GJ INPUT PERCAPITA 339

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementation of energy conservation. People from communities throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to energy conservation. Beginning in 1984, Yukon College, through the Education Extension Program will offer courses in Beaver Creek for those who are interest in retrofit technology, energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved. This will result in reductions of oil use, both through direct space heating and energy requirements for fuel transport. Residential buildings sampled in Beaver Creek for this study, indicate retrofit potential indices (RPI) as high as 16. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in Beaver Creek and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load ranges from 130 to 200 Gigajoules per household. The lower figure undoubtably reflects seasonal occupation of the houses and/or the utilization of wood as a supplementary heating fuel. The upper figure represents totally wood heated households. Three factors contribute to this high value. Firstly, the typical inefficiency of most wood burning appliances, secondly, the inaccuracy of estimated "cord" value, and thirdly, the residences which use wood as the primary heating source are generally less thermally efficient than other residences in the community.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

The diesel fueled electric generator in Beaver Creek uses an estimated 13000 Gigajoules per year. It may be possible to recover much of this energy as available waste heat. After conservation, the net space heating load of 8750 Gigajoules could be further offset by the recovery of waste heat from the generator. This available energy should be specifically evaluated in terms of identifying buildings which have sufficiently high heating demands, and are close enough to the power plant to make heat transmission effective.

Other energy supply options for Beaver Creek are discussed in the following sections.

5.4.1.3 Energy Supply Alternatives

(a) Heat Recovery

Heat recovery from the diesel generators may be feasible for some of the closer buildings in Beaver Creek, such as the nursing station and community hall at the south west end of town. It may even be feasible to extend the system to the highway to serve some of the major lodge buildings.

Otherwise Beaver Creek appears to be lacking in obvious alternative resources, thus diesel based electric generation will continue in the town for some time. To better utilize this energy, it may even be justified to move the generators such that hot water distribution is more economic. See Section 5.1.2 for further comments on heat recovery.

(b) Wood

Wood is not plentiful in the Beaver Creek area but there is enough for individuals to go out and collect for supplementary heating in households. In fact, very little of this is done because many of the houses in Beaver Creek are government owned and there is little incentive for occupants to invest in wood stoves or to commit the time necessary to use wood.

There is a small fire-killed forest area near Snag, about 45 km drive from Beaver Creek. The stand density is not known but it covers about 240 hectares immediately adjacent to the road. A cooperative type of arrangement for collecting wood for community use could be considered.

c) Propane substitution - power heat... district distribution.

5.4.1.4 Energy Use Data for Beaver Creek

TABLE 5-17a

YTG & MUNICIPAL BUILDINGS ENERGY USE: BEAVER CREEK
SOURCE: YTG Energy Branch, YTG Supply Services Branch, YECL

#	DESCRIPTION	83-4 FUEL EST LTR*1000	82-3 ELEC MWH	82-3 FUEL LITRES	81-2 ELEC MWH	81-2 FUEL GAL	80-1 ELEC MWH	80-1 FUEL GAL
100	School & Teachrg	25	27	12624	18	4862	20	3419
118	Grader Sta	34	30	34144	30	10775		8216
101	Tourist Info Centr				7		7	
102	Firehall	7						
115	Pumphse & Wtr Supl	14	15	9667	13	4223		3093
117	POL Stor							
	Car plugs				8			
	Tfk & St Lights		59		55		43	
	TOTAL	79	131	56435	131	19860	70	14728

MUNICIPAL GOVT BUILDINGS: Community Hall, Curling Rink, Pool

BAND COUNCIL BUILDINGS:

#	DESCRIPTION	80-1 ELEC GJ	81-2 ELEC GJ	82-3 ELEC GJ	AVG 80-3 ELEC GJ	80-1 FUEL GJ	81-2 FUEL GJ	82-3 FUEL GJ	AVG 80-3 FUEL GJ	AVG FUEL GJ	EST 83-4 FUEL GJ
100	School & Teachrg	72	66	98	79	613	872	499	661	814	968
118	Grader Sta		108	108	108	1473	1932	1349	1585	1464	1343
101	Tourist Info Centr	23	23		23						
102	Firehall									273	273
115	Pumphse & Wtr Supl		48	54	51	555	757	382	565	559	553
117	POL Stor										
	Car plugs		28		28						
	Tfk & St Lights	157	199	212	189						
	TOTAL				478				2811	3110	3136
	AVG w/o school, grader stn, st lights			MWH:	11			GJ:	565	416	413

TABLE 5-17b

GOVERNMENT FUEL REQUIREMENTS ESTIMATES - 1983-84
SOURCE: YTG Supply & Services, Fed. Govt. Supply & Services
Data in Litres X 1000

Community	YTG Bldgs	Education	Fed. Govt.	F.G. Res.
Beaver Creek	14	25	4	
	34		32	
	7		21	
Total Litres:	55	25	56	
Total # bldgs	6	1	8	5
GJ:	2169	968	2220	
Total Govt.:	4388			
Avg GJ/bldg:	361	968	277	

TABLE 5-17c

RCMP BUILDINGS - ENERGY USE: BEAVER CREEK
SOURCE - RCMP, Whitehorse

DESCRIPTION	VOL (M3)	81-82 LITRES	MJ/DDY	82-83 LITRES	MJ/DDY	82-83 MWH	AVG YR GJ	KJ/M3 /DDY	RPI	83-4 FUEL EST litres	GJ
BEAVER CREEK		DDY=	9179	DDY=	8979		8838				
Detachment	667	7112	31	5966	26	33	251	43	11	31900	1260
#1 residence	252	2374	10	2477	11		93	42	4		0
DW 1978	268	3290	14	3789	17	17	136	58	8		0
AVERAGE	396	4259	18	4077	18	25	160	47	7		
TOTAL	1187	12776	55	12232	54	49	481	46		31900	1260
											2.62

TABLE 5-17d

COMMERCIAL ELECTRICITY: BEAVER CREEK
SOURCE:YTG Econ Devt Branch
Yukon Business Directory, NorthwesTel Directory

COMMERCIAL BUILDING	82-83 MWH	ELEC GJ	$/MWH	IC
Community Hall	7.71	28	23.2	1 R96
Community Pool	5.85	21	32.7	1 R96
				3 R96
				1 J60
				3 Q91
				1 Q92
				3 R98
				1 R99
				1 H48
				1 H49
AVERAGE MWH	6.78			
TOTAL MWH	14			
OTHER COMML USERS:	11			
TOTAL COMML USERS:	13			13

TABLE 5-17e

YUKON HOUSING RENTAL UNITS: BEAVER CREEK
SOURCE: YTG Energy Branch, Yukon Housing Corp

BUILDING	YEAR	VOLUME M3	80-81 LITRES	MJ/DDY	81-82 LITRES	MJ/DDY	81-82 ELEC KWH	AVG YR GJ	KJ/M3 /DDY	RPI *******
BEAVER CREEK DDY				8978		9179		9838		
old fed housing	48	402	5412	24	3923	17		180	51	9 *
two story con. bsmt.		402	4041	18	4249	18		159	45	7 *
		402	4831	21	6043	26	3625	209	59	12 *
		402	4318	19	6524	28	6389	208	59	12 *
		402	4086	18	5071	22		176	50	9 *
		402	5502	24	6942	30	2792	239	67	16 **
AVERAGE		402	4698	21	5459	23	4269	195	55	11 *

TABLE 5-17f

GOVERNMENT OF CANADA HEATING ASSISTANCE PAYMENTS: BEAVER CREEK
SOURCE:YTG Dept. of Finance
PERIOD:1 Ap82-31 Mr83 MAX $/LITRE: .45

TYPE	AREA	VOLUME M3	PERIOD	LITRES	GJ	MJ/M3	AVG YR GJ	KJ/M3 /DDY	RPI *******
		DDY50-80=	9838		DDY82-83=	8979			
YHC110,Hiwy	1771	402	8204.8302	3444	136	339	134	38	5
YHC107,Hiwy	1771	402	8204.8302	3581	141	352	139	39	5
YHC106,Hiwy	1771	402	8204.8302	4045	160	398	157	44	7 *
AVERAGE	1771	402		3690	146	363	143	40	6

5.4.2 Burwash Landing

5.4.2.1 Cultural and Economic Setting

Located on an elevated terrace on the northwest side of Kluane Lake, the present site of Burwash dates from 1904 when a trading post was established here to service people prospecting and working in the northern creeks. Before the Alaska Highway was built, an old wagon road linked Kluane and Whitehorse (via Burwash). It is a native community and archaeologists have found evidence that human occupation of the Kluane Lake region extends back at least 8,000 years.

5.4.2.2 Community Energy Planning for Burwash Landing

If the community of Burwash Landing wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Burwash Landing.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Burwash Landing, then the estimated space heating load of 9000 Gigajoules could be reduced by 50 percent to 4500 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Burwash Landing, the other sector which uses a large proportional amount of energy for space heating is the Yukon and Municipal Government sector. Yukon and Municipal Government buildings consume 22 percent of the space heating fuel and comprise only 16 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public buildings will offer the most favorable conservation/ retrofit opportunities.

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementation of energy conservation. People from communities throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to energy conservation. Beginning in 1984, Yukon College, through the Education Extension Program will offer courses in Burwash Landing for those who are interest in retrofit

TABLE 5-18

COMMUNITY ENERGY PROFILE: BURWASH LANDING POPULATION: 73

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL SPHT GJ	%	TOTAL GJ	%
FED GOVERNMENT	3	9	16	48	12	212	636	7	809	8
YUKON & MUNICPL GOVT	5	15	16	80	20	392	1960	22	2248	22
EDUCATION	1	3	9	9	2	428	428	5	460	5
COMMERCIAL	4	12	31	123	31	246	984	11	1426	14
FED GOVT RESIDENTIAL										
YUKON HSG CORP										
RESIDENTIAL										
RESIDENTIAL (ttl wd)	20	61	7	140	35	238	4760	55	5264	52
TOTAL	33			400			8768		10207	
TOTAL RESIDENTIAL	20			140			GJ USED PERCAPITA		140	

kWh/litre gen eff: 3.09 5115 GJ TOTAL GJ INPUT: 13883
(generator @ Destruction Bay)

GJ INPUT PERCAPITA 190

technology, energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved. This will result in reductions of oil use, both through direct space heating and energy requirements for fuel transport. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in Burwash Landing and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load is 238 Gigajoules per household. This high figure represents totally wood heated households. Three factors contribute to this high value. Firstly, the typical inefficiency of most wood burning appliances, secondly, the inaccurarcy of estimated "cord" value, and thirdly, the residences which use wood as the primary heating source are generally less thermally efficient than other residences in the community.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

The diesel fueled electric generator in Burwash Landing uses an estimated 5000 Gigajoules per year. It may be possible to recover much of this energy as available waste heat. After conservation, the net space heating load of 4500 Gigajoules could be further offset by the recovery of waste heat from the generator. This available energy should be specifically evaluated in terms of identifying buildings which have sufficiently high heating demands, and are close enough to the power plant to make heat transmission effective.

Other energy supply options for Burwash Landing are discussed in the following sections.

5.4.2.3 Energy Supply Alternatives

(a) Wood

Native residences are already substantially heated by wood (average 15 to 20 "cords" per year). Other buildings, however, could be served by wood-fired systems for space and water heating. Such buildings include the church, school, lodge, band office, store, community hall and washhouse/laundry. None of these buildings is large enough to warrant the installation of a chip-fired system, but log burning is certainly feasible.

There are no fire-kill areas around Burwash Landing and the Band travels up to 120 km. to obtain its wood. See the general comments in Section 5.1.2 on community wood use. Some wood is hauled into the community and is available at 100 $/CD.

(b) Hydro

Two sites showing potential for small hydro development are evident in the area south of the community at Halfbreed Creek and Bocks Creek. It is reported that these creeks "freeze-up" during the winter, which may limit hydro potential unless adequate storage is provided. Development at either of these sites would also provide service to Destruction Bay. Since Burwash Landing's electric supply is the diesel generating station at Destruction Bay, transmission facilities already extend between the two. Further comments on small hydro developments are provided in Section 5.1.2.

(c) Wind Power

Wind studies are already being conducted in the Burwash Landing area. Existing records indicate that winds in excess of 10 kph are quite frequent. However, electrical generation from wind is not economically feasible at the present level of technological development for systems large enough to supply a community the size of Burwash Landing.

The use of wind turbines for water pumping has been effectively demonstrated, is much simpler and relatively independent of demand load. A future possibility in this regard would be the use of wind power in combination with a small hydro development to provide pumped storage.

5.4.2.4 Energy Use Data for Burwash Landing

TABLE 5-19a

YTG & MUNICIPAL BUILDINGS ENERGY USE: BURWASH LANDING
SOURCE: YTG Energy Branch, YTG Supply Services Branch, YECL

#	DESCRIPTION	83-4 FUEL EST LTR*1000	82-3 ELEC MWH	82-3 FUEL LITRES	81-2 ELEC MWH	81-2 FUEL GAL	80-1 ELEC MWH	80-1 FUEL GAL
	Keetsadunku School	11	7	8568	11	3090	9	2396
200	Fire Hall	5	1	3368				
	Band ofc, com hall, washouse			35714				
	Tfk & St Lights		11		9		8	
	TOTAL	15	19	47650	20	3090	17	2396

MUNICIPAL GOVT BUILDINGS: Museum

BAND COUNCIL BUILDINGS: Band Ofc, Community Hall, Washouse/Laundry

#	DESCRIPTION	80-1 ELEC GJ	81-2 ELEC GJ	82-3 ELEC GJ	AVG 80-3 ELEC GJ	80-1 FUEL GJ	81-2 FUEL GJ	82-3 FUEL GJ	AVG 80-3 FUEL GJ	AVG FUEL GJ	EST 83-4 FUEL GJ
	Keetsadunku School	32	40	24	32	430	554	338	441	428	415
	Fire Hall			4	4			133	133	157	182
	Band ofc, com hall, washouse							1411	1411	1411	
	Tfk & St Lights	28	33	40	33						
	TOTAL				69				1984	1996	596
	AVG w/o school, st lights			MWH:	1			GJ:	772	784	182

TABLE 5-19b

GOVERNMENT FUEL REQUIREMENTS ESTIMATES - 1983-84
SOURCE: YTG Supply & Services, Fed. Govt. Supply & Services
Data in Litres X 1000

Community	YTG Bldgs	Education	Fed. Govt.	F.G. Res.
Burwash Landg	5	11	3 13	
Total Litres:	5	11	16	
Total # bldgs	1	1	3	
GJ:	182	415	636	
Total Govt.:	818			
GJ per Bldg.:	182	415	212	

TABLE 5-19c

COMMERCIAL ELECTRICITY: BURWASH
SOURCE:YTG Econ Devt Branch
Yukon Business Directory, NorthwesTel Directory

COMMERCIAL BUILDING	82-83 MWH	ELEC GJ	$/MWH	#	IC
				1	J60
				1	J63
				1	091
				1	R98

AVERAGE MWH

TOTAL MWH

OTHER COMML USERS: 4

TOTAL COMML USERS: 4

5.4.3 Destruction Bay

5.4.3.1 Cultural and Economic Setting

First settled in 1942 by a U.S. Army road crew, the community virtually owes its existence to the building of the Alaska Highway. It is now a communications and transportation (CN Telecommunications) as well as a stop-over for tourists on the Alaska Highway. A Highway Maintenance camp is also located here.

The community is split into an east and west section. The eastern area is primarily residential and the western area contains the lodge, service station and YTG buildings. It is located on the shore of Kluane Lake.

5.4.3.2 Community Energy Planning for Destruction Bay

If the community of Destruction Bay wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Destruction Bay.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Destruction Bay, then the estimated space heating load of 11000 Gigajoules could be reduced by 50 percent to 5500 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Destruction Bay, the other sector which uses a large proportional amount of energy for space heating is the Yukon and Municipal Government sector. Yukon and Municipal Government buildings consume 23 percent of the space heating fuel and comprise only 16 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public buildings will offer the most favorable conservation/retrofit opportunities.

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementation of energy conservation. People from communities throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to energy conservation. Beginning in 1984, Yukon College,

TABLE 5-20

COMMUNITY ENERGY PROFILE: DESTRUCTION BAY POPULATION: 80

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL SPHT GJ	%	TOTAL GJ	%
FED GOVERNMENT	3	6	16	48	7	145	435	4	608	5
YUKON & MUNICPL GOVT	8	16	16	128	18	306	2448	23	2908	22
EDUCATION	1	2	19	19	3	435	435	4	503	4
COMMERCIAL	11	22	28	305	44	222	2440	23	3537	27
FED GOVT RESIDENTIAL	8	16	9	72	10	182	1456	13	1715	13
YUKON HSG CORP										
RESIDENTIAL	13	26	6	84	12	150	1968	18	2270	17
RESIDENTIAL (ttl ed)	7	13	6	44	6	238	1637	15	1796	13
TOTAL	51			700			10819		13337	
TOTAL RESIDENTIAL	28			200			GJ USED PERCAPITA		167	
	kWh/litre gen eff:		3.09	8951	GJ		TOTAL GJ INPUT:		19771	
							GJ INPUT PERCAPITA		247	

through the Education Extension Program will offer courses in Destruction Bay for those who are interest in retrofit technology, energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved. This will result in reductions of oil use, both through direct space heating and energy requirements for fuel transport. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended tnat additional data on building volumes and annual energy consumption be obtained for other buildings in Destruction Bay and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load ranges from 150 to 238 Gigajoules per household. The lower figure undoubtably reflects seasonal occupation of the houses and/or the utilization of wood as a supplementary heating fuel. The upper figure represents totally wood heated households. Three factors contribute to this high value. Firstly, the typical inefficiency of most wood burning appliances, secondly, the inaccuracy of estimated "cord" value, and thirdly, the residences which use wood as the primary heating source are generally less thermally efficient than other residences in the community.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

The diesel fueled electric generator in Destruction Bay uses an estimated 9000 Gigajoules per year. It may be possible to recover much of this energy as available waste heat. After conservation, the net space heating load of 5500 Gigajoules could be further offset by the recovery of waste heat from the generator. This available energy should be specifically evaluated in terms of identifying buildings which have sufficiently high heating demands, and are close enough to the power plant to make heat transmission effective.

Other energy supply options for Destruction Bay are discussed in the following sections.

5.4.3.3 Energy Supply Alternatives

(a) Hydro

Two potential hydro sites were indicated by the map study at Halfbreed Creek and Bocks Creek, south and west of the community. Possible sites on Kluane River and Duke River have also been reported. Any hydro development in the area would include Burwash landing as it is already served by a transmission line from the diesels outside Destruction Bay.

At both sites, the apparent energy available exceeds that required by the two communities so it must be investigated whether an appropriately sized development could be designed which would yield an economic unit cost on energy. For further comments on small hydro development, see Section 5.1.2.

(b) Wood

In Destruction Bay, with its preponderance of government households, little wood is used. There are no readily accessible fire kill areas near the community and residents of nearby Burwash Landing indicate they travel 120 kilometers to collect their fuel wood or pay up to $100/CD. Nevertheless, with some incentives, wood use for residential space heating could reduce oil consumption. See Section 5.1.2 for general comments on community wood use.

(c) Coal

A coal source in the Kluane Game Sanctuary was used prior to the construction of the Alaska Highway which could provide an alternative to wood.

(d) Wind Power

The Destruction Bay area is one of the few in the Yukon that shows sufficient wind strength and frequency to consider the use of wind energy. A demonstration program to further document the wind regime is in place in the area. Community scale wind powered electric generation has been a disappointment to date with many technical problems encountered. A more proven application of wind power, however, has been for water pumping.

A future consideration for Destruction Bay could be the use of pumped storage driven by wind power in combination with a small hydro scheme.

5.4.3.4 Energy Use Data Tables for Destruction Bay

TABLE 5-21a

YTG & MUNICIPAL BUILDINGS ENERGY USE: DESTRUCTION BAY
SOURCE: YTG Energy Branch, YTG Supply Services Branch, YECL

#	DESCRIPTION	83-4 FUEL EST LTR*1000	82-3 ELEC MWH	82-3 FUEL LITRES	81-2 ELEC MWH	81-2 FUEL GAL	80-1 ELEC MWH	80-1 FUEL GAL
171	School & Teachrg	11	17	13733	19	2790	15	2531
186	Grader Sta	25	31	28231	51	7224		10329
172	Fire Hall	9	10	10224				
181	Pumphouse	5		4276		776		432
183	Curling Rink							
	Car plugs				5			
	Sewage Lift Sta							
	Tfk & St Lights		51		42		36	
	TOTAL	50	109	56464	117	10790	51	13292

MUNICIPAL GOVT BUILDINGS: Community Hall

BAND COUNCIL BUILDINGS: Band Ofc

#	DESCRIPTION	80-1 ELEC GJ	81-2 ELEC GJ	82-3 ELEC GJ	AVG 80-3 ELEC GJ	80-1 FUEL GJ	81-2 FUEL GJ	82-3 FUEL GJ	AVG 80-3 FUEL GJ	AVG FUEL GJ	EST 83-4 FUEL GJ
171	School & Teachrg	54	68	61	61	454	500	542	499	467	435
186	Grader Sta		185	111	148	1852	1295	1115	1421	1204	988
172	Fire Hall			37	37			404	404	382	359
181	Pumphouse					77	139	169	129	155	182
183	Curling Rink										
	Car plugs		17		17						
	Sewage Lift Sta										
	Tfk & St Lights	130	152	185	156						
	TOTAL				419				2452	2208	1963
	AVG w/o school, grader stn, st lights			MWH:	7			GJ:	266	268	271

TABLE 5-21b

GOVERNMENT FUEL REQUIREMENTS ESTIMATES - 1983-84
SOURCE: YTG Supply & Services, Fed. Govt. Supply & Services
Data in Litres X 1000

Community	YTG Bldgs	Education	Fed. Govt.	F.G. Res.
Destrctn Bay	25	11	6	37
	9		5	
	5			
Total Litres:	39	11	11	37
Total # bldgs	5	1	3	8
GJ:	1529	435	435	1454
Total Govt.:	1963			
GJ per Bldg.:	306	435	145	182

TABLE 5-21c

RCMP BUILDINGS - ENERGY USE: DESTRUCTION BAY
SOURCE - RCMP, Whitehorse

DESCRIPTION	VOL (M3)	81-82 LITRES	MJ/DDY	82-83 LITRES	MJ/DDY	82-83 AVG MWH	YR GJ	KJ/M3 /DDY	RPI	83-4 FUEL litres	EST GJ
DESTRUCTION BAY		DDY=	6058	DDY=	6058		8170				
Det/quarters trailer	252	1950	13				104	50	5	4600	182

TABLE 5-21d

COMMERCIAL ELECTRICITY: DESTRUCTION BAY
SOURCE:YTG Econ Devt Branch
Yukon Business Directory, NorthwesTel Directory

AL BLDG	82-83 MWH	ELEC GJ	$/MWH	#	IC
MUSEUM,KI	2.58	9	25.4	1	N83
COMM CLUB	11.81	43	27.2	1	R96
MOTEL, Ta	134.74	485	23.8	1	Q91
				2	Q91
				2	J63
				2	G45
				1	H48
				1	G49
AVG MWH	49.71				
TOTAL MWH	149				
OTHER COM	8				
TOTAL COM	11				

TABLE 5-21e

GOVERNMENT OF CANADA HEATING ASSISTANCE PAYMENTS: DESTRUCTION BAY
SOURCE:YTG Dept. of Finance
PERIOD:1 Ap82-31 Mr83 MAX $/LITRE: .44

TYPE	AREA	VOLUME M3	PERIOD	LITRES	GJ	MJ/M3	AVG YR GJ	KJ/M3 /DDY	RPI #######
DESTRN BAY		DDY50-80=	8170		DDY82-83=	8236			
PVT,	1512	343	205.303	1857	73	214	73	26	2

5.4.4 Carcross

5.4.4.1 Cultural and Economic Setting

Originally inhabited by Tlingit-speaking Indians, Carcross, formerly known as Caribou Crossing, was first settled by white men during the Klondike Gold Rush. By 1900 the White Pass and Yukon Railway was servicing the community and in 1901 an Anglican residential school was set up. Carcross still functions as a road/rail service center.

The majority of the community population resides on the north shore of Lake Bennett while the native village of approximately 50 people is situated to the south of the main settlement.

5.4.4.2 Community Energy Planning for Carcross

If the community of Carcross wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Carcross.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Carcross, then the estimated space heating load of 26000 Gigajoules could be reduced by 50 percent to 13000 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Carcross, the other sector which uses a large proportional amount of energy for space heating is the Residential sector. Residential buildings consume 53 percent of the space heating fuel and comprise only 46 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public buildings will offer the most favorable conservation/ retrofit opportunities.

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementation of energy conservation. People from communities throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to energy conservation. Beginning in 1984, Yukon College, through the Education Extension Program will offer courses

TABLE 5-22

COMMUNITY ENERGY PROFILE: CARCROSS

POPULATION: 270

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL SPHT GJ	%	TOTAL GJ	%
FED GOVERNMENT	3	2	17	51	5	200	600	2	783	3
YUKON & MUNICPL GOVT	8	6	17	136	14	200	1600	6	2089	7
EDUCATION	1	1	31	31	3	2223	2223	8	2335	8
COMMERCIAL	10	8	18	182	18	200	2000	8	2655	9
FED GOVT RESIDENTIAL	2	2	16	32	3	100	200	1	315	1
YUKON HSG CORP	9	7	12	108	11	125	1125	4	1513	5
RESIDENTIAL	35	28	5	172	17	134	4658	18	5276	18
RESIDENTIAL (ttl wd)	58	46	5	288	29	238	13861	53	14897	50
TOTAL	126			1000			26267		29864	
TOTAL RESIDENTIAL	104			600						

GJ USED PERCAPITA 111

kWh/litre gen eff: GRID

TOTAL GJ INPUT: 29864

GJ INPUT PERCAPITA 111

in Carcross for those who are interest in retrofit technology, energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved. This will result in reductions of oil use, both through direct space heating and energy requirements for fuel transport. Residential buildings sampled in Carcross for this study, indicate retrofit potential indices (RPI) as high as 21. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in Carcross and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load ranges from 134 to 238 Gigajoules per household. The lower figure undoubtably reflects seasonal occupation of the houses and/or the utilization of wood as a supplementary heating fuel. The upper figure represents totally wood heated households. Three factors contribute to this high value. Firstly, the typical inefficiency of most wood burning appliances, secondly, the inaccuracy of estimated "cord" value, and thirdly, the residences which use wood as the primary heating source are generally less thermally efficient than other residences in the community.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

Since Carcross is connected to the hydroelectric power grid, electricity is an available renewable resource which could be used for space heating. However, since electricity supplies higher grade energy requirements which cannot be feasibly provided by fuel, then it may be more prudent to utilize electricity to sustain the desired level of economic development, than to use it as an alternative source for space heating. Only those buildings which meet the recommendations for the upcoming Northern Building Energy Standards (NRC-DBR) can be considered as viable candidates for electrical space heating.

Another renewable energy supply option which would be more favorable than hydro-electric power for space heating in

Carcross is the efficient utilization of wood as a space heating fuel, and a well organized fuel wood delivery system.

Other energy supply options for Carcross are discussed in the following sections.

5.4.4.3 Energy Supply Alternatives

(a) Hydro

Being already on the central grid, the best off-oil opportunity for Carcross may be to substitute electric power for oil consumption, primarily for space and water heating in larger buildings. The school, community hall, or highways maintenance camp would be appropriate candidates. The appropriateness of this measure will depend on the capacity on the grid. See Section 5.1.2 for further comments.

(b) Wood

Wood is apparently not abundant in the immediate area of Carcross, but there are good stands to the south in B.C. There is a also large fire-killed area about 70 km. north near Whitehorse. There is also another large burn within 70 km on the Atlin Road. Every residence in Carcross could be heating with wood. A commercial wood supply enterprise would probably help encourage more wood use. See Section 5.1.2 for general comments on community wood use.

(c) Coal

If coal production is commenced on the Whitehorse coal property north of Carcross, good quality, low sulphur coal could be available for heating needs. The best use of coal would be for firing boilers at the larger buildings in the community and direct heating in wood stoves.

5.4.4.4 Energy Use Data Tables for Carcross

TABLE 5-23a

YTG & MUNICIPAL BUILDINGS ENERGY USE: CARCROSS

SOURCE: YTG Energy Branch, YTG Supply Services Branch, YECL

#	DESCRIPTION	83-4 FUEL EST LTR*1000	82-3 ELEC MWH	82-3 FUEL LITRES	81-2 ELEC MWH	81-2 FUEL GAL	80-1 ELEC MWH	80-1 FUEL GAL
134	School	40	21	102287	38	10881	34	3781
131	Grader Sta	15	12	21147	14	2885		3271
149	Clsrm Prtbl(w/sch)							
148	Teacherage							
137	Firehall	9	11	4915		366		657
	Pool		8			1241		
	Rec Centre			3900				
	CYI Bldg			3126				
	Band Ofc			1549				
	Tfk & St Lights		48		46		63	
	TOTAL	65	101	136924	97	15373	97	7709

MUNICIPAL GOVT BUILDINGS: Pool, Community Club, Wtrtrk garage

BAND COUNCIL BUILDINGS: Band Ofc, CYI Bldg, Rec Centre

#	DESCRIPTION	80-1 ELEC GJ	81-2 ELEC GJ	82-3 ELEC GJ	AVG 80-3 ELEC GJ	80-1 FUEL GJ	81-2 FUEL GJ	82-3 FUEL GJ	AVG 80-3 FUEL GJ	AVG FUEL GJ	EST 83-4 FUEL GJ
134	School	121	136	77	111	678	1951	4040	2223	1911	1598
131	Grader Sta		49	42	46	587	517	835	646	619	593
149	Clsrm Prtbl(w/sch)										
148	Teacherage										
137	Firehall			41	41	118	66	194	126	243	359
	Pool			29	29		223		223	223	
	Rec Centre							106	106	106	
	CYI Bldg							123	123	123	
	Band Ofc							61	61	61	
	Tfk & St Lights	227	165	173	188						
	TOTAL				415				3508	3286	2550
	AVG w/o school, grader stn, st lights			MWH:	10			GJ:	129	151	359

TABLE 5-23b

GOVERNMENT FUEL REQUIREMENTS ESTIMATES - 1983-84
SOURCE: YTG Supply & Services, Fed. Govt. Supply & Services
Data in Litres X 1000

Community	YTG Bldgs	Education	Fed. Govt.	F.G. Res.
Carcross	15	28	9	4
	9		3	4
			10	
Total Litres:	24	28	22	8
Total # bldgs	2	1	3	2
GJ:	952	1114	861	316
Total Govt.:	1813			
GJ per Bldg.:	476	1114	287	158

TABLE 5-23c

RCMP BUILDINGS - ENERGY USE: CARCROSS
SOURCE - RCMP, Whitehorse

	VOL	81-82	MJ/DDY	82-83	MJ/DDY	82-83	AVG YR	KJ/M3		83-4 FUEL	EST
DESCRIPTION	(M3)	LITRES		LITRES		MWH	GJ	/DDY	RPI	litres	GJ
CARCROSS		DDY=	7361	DDY=	6371		6964				
Detachment	595	5298	28	3684	23	28	179	43	8	18200	719
DW 1976	247	2611	14	1817	11	17	80	51	4		
MQ	223			1143	7		49	32	2		
AVERAGE	355	3955	14	2215	14	23	105	39	5		
TOTAL	1065	7909	42	6644	41	45	291	39		18200	719
											2.47

TABLE 5-23d

COMMERCIAL ELECTRICITY: CARCROSS
SOURCE:YTG Econ Devt Branch
Yukon Business Directory, NorthwesTel Directory

COMMERCIAL BUILDING	82-83 MWH	ELEC GJ	$/MWH	#	IC
HOTEL	42.31	152	14.2	1	Q91
				1	C41
				1	G45
				1	J63
				1	J60
				1	Q92
				2	R98
				1	N33
				1	R99
AVERAGE MWH	42.31		14.2		
TOTAL MWH	42				
OTHER COMML USERS:	9				
TOTAL COMML USERS:	10				

TABLE 5-23e

COMMERCIAL BUILDING ENERGY USE: CARCROSS
SOURCE: YTG Energy Branch Commercial Energy Audits

BUILDING	VOLUME M3	ELEC MWH	PERIOD	FUEL LITRES	PERIOD	DDY	FUEL GJ	MJ/DDY	AVG YR GJ	KJ/M3 /DDY	RPI
									6964		
POOL	552	8	104.108	5634	105.107	502	223	443	292	803	235
GEN.STORE	448	5	106.206	24	CDS 81-2	7361	335	45	317	102	32
HOTEL Caribou	1530	31	1980 est	40	CDS 80-1	6238	560	90	625	59	37
AVERAGE	843	15		1899			372	193	411		

TABLE 5-23f

YUKON HOUSING RENTAL UNITS: CARCROSS
SOURCE: YTG Energy Branch, Yukon Housing Corp

BUILDING	YEAR	VOLUME M3	80-81 LITRES	MJ/DDY	81-82 LITRES	MJ/DDY	81-82 ELEC KWH	AVG YR GJ	KJ/M3 /DDY	RPI *******
CARCROSS DDY				6238		7361		6964		
bi-level split entry	73	434	2424	15	2107	11		93	31	3
		434	3146	20	1970	11		106	35	4
		434	3187	20	2674	14		120	40	5
AVERAGE		434	2919	18	2250	12		106	35	4
bungalow on crawl sp	73	265	3087	20	3051	16	24088	125	68	8 *
		265	3024	19	2969	16	8696	122	66	8 *
AVERAGE		265	3055	19	3010	16	16392	124	67	8 *
milled log house 1	77	314	4127	26	1507	8	10580	119	54	6 *
		314	4159	26	3087	17	8210	149	68	10 *
AVERAGE		314	4143	26	2297	12	9395	134	61	8 *
milled log house 2	77	230	3405	22	3727	20	12099	145	90	13 **
		230	2783	18	3378	18	10472	124	78	10 *
AVERAGE		230	3094	20	3553	19	11286	135	84	11 *
TOTAL AVERAGE		320	3288	21	2669	14	12492	122	55	7 *

TABLE 5-23g

GOVERNMENT OF CANADA HEATING ASSISTANCE PAYMENTS: CARCROSS
SOURCE:YTG Dept. of Finance
PERIOD:1 Au82-31 Mr83 MAX $/LITRE: .41

TYPE	AREA	VOLUME M3	PERIOD	LITRES	GJ	MJ/DDY	AVG YR GJ	KJ/M3 /DDY	RPI *******
CARCROSS		DDY50-80=	6964		DDY82-83=	6732			
YHC140	1912	433	8209.8306	2818	111	17	115	38	4
RPVT	772	175	821026	1537	61	9	63	52	3
PVT	1008	229	8209.8301	2303	91	18	124	78	10 *
PVT	1560	354	8209.8302	4922	194	33	228	92	21 ***
AVERAGE	1313	298		2895	114	19	132	65	9 *

5.4.5 Carmacks

5.4.5.1 Cultural and Economic Setting

Before the Klondike Gold Rush, Carmacks was an Indian trading camp. However, after George Washington Carmacks discovered gold (hence starting the Gold Rush) his roadhouse, and eventually the community, became known as Carmacks. The settlement provided facilities and services for both road (Dalton Trail) and river (steamer) travellers. Later Tantalus Coal Mine was established and operated between 1905 - 1922 (south bank of Yukon River) and later the Tantalus Butte Mine located on the north bank of the Yukon River operated from 1923 to 1938 and 1947 to 1981. Completion of the Klondike Highway in 1950 turned Carmacks into a road service center. Subsequently Indians from outlying river settlements moved into Carmacks. At present, 60% of the population is Northern Tutchone Indian. The Campbell Highway was completed in 1969 provides a link from Carmacks to Watson Lake through Faro and Ross River.

5.4.5.2 Community Energy Planning for Carmacks

If the community of Carmacks wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Carmacks.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Carmacks, then the estimated space heating load of 34000 Gigajoules could be reduced by 50 percent to 17000 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Carmacks, the other sector which uses a large proportional amount of energy for space heating is the Federal sector. Federal buildings consume 10 percent of the space heating fuel and comprise only 6 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public buildings will offer the most favorable conservation/ retrofit opportunities.

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementa-

TABLE 5-24

COMMUNITY ENERGY PROFILE: CARMACKS POPULATION: 339

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL SPHT GJ	%	TOTAL GJ	%
FED GOVERNMENT	9	6	23	207	11	395	3559	10	4304	10
YUKON & MUNICPL GOVT	11	8	23	253	13	134	1474	4	2384	6
EDUCATION	1	1	144	144	8	2209	2209	6	2727	7
COMMERCIAL	17	12	29	496	26	235	3995	12	5779	14
FED GOVT RESIDENTIAL	5	3	11	56	3	152	758	2	961	2
YUKON HSG CORP	23	16	11	259	14	160	3680	11	4612	11
RESIDENTIAL	29	20	6	177	9	119	3480	10	4117	10
RESIDENTIAL (ttl wd)	51	35	6	307	16	300	15228	44	16334	40
TOTAL	146			1900			34383		41217	
TOTAL RESIDENTIAL	108			800		GJ USED PERCAPITA			122	
	kWh/litre gen eff: GRID					TOTAL GJ INPUT:			41217	
						GJ INPUT PERCAPITA			122	

tion of energy conservation. People from communities throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to energy conservation. Beginning in 1984, Yukon College, through the Education Extension Program will offer courses in Carmacks for those who are interest in retrofit technology, energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved. This will result in reductions of oil use, both through direct space heating and energy requirements for fuel transport. Residential buildings sampled in Carmacks for this study, indicate retrofit potential indices (RPI) as high as 10. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in Carmacks and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load ranges from 119 to 300 Gigajoules per household. The lower figure undoubtably reflects seasonal occupation of the houses and/or the utilization of wood as a supplementary heating fuel. The upper figure represents totally wood heated households. Three factors contribute to this high value. Firstly, the typical inefficiency of most wood burning appliances, secondly, the inaccuracy of estimated "cord" value, and thirdly, the residences which use wood as the primary heating source are generally less thermally efficient than other residences in the community.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

Since Carmacks is connected to the hydroelectric power grid, electricity is an available renewable resource which could be used for space heating. However, since electricity supplies higher grade energy requirements which cannot be feasibly provided by fuel, then it may be more prudent to utilize electricity to sustain the desired level of economic development, than to use it as an alternative source for space heating. Only those buildings which meet the recommendations for the upcoming Northern Building

Energy Standards (NRC-DBR) can be considered as viable candidates for electrical space heating.

Another renewable energy supply option which would be more favorable than hydro-electric power for space heating in Carmacks is the efficient utilization of wood as a space heating fuel, and a well organized fuel wood delivery system.

Other energy supply options for Carmacks are discussed in the following sections.

5.4.5.3 Energy Supply Alternatives

(a) Hydro

Carmacks is on the central grid and thus, there is an opportunity to use more hydro electric power. See Section 5.1.2 for a discussion of hydro capacity implications for grid connected communities.

(b) Coal

Coal has previously been produced from the Tantalus Butte Mine near Carmacks, primarily for Cyprus Anvil's use. This mine has since been abandoned. However, there are other coal resources documented in the Carmacks area. Even if it will not be economic to produce on a large scale industrial basis from these abandoned properties, it may be possible to economically retrieve coal suitable for individual space heating requirements.

If a large coal operation starts up to supply Cyprus Anvil, this would provide an additional source.

(c) Wood

Native households in Carmacks rely almost exclusively on wood for space heating requirements while the rest of the population tends to use oil as the primary fuel. Incentives for encouraging further wood usage should be developed.

Wood fired boilers could be considered for some of the larger buildings with hydronic heating systems, but further study of the comparative economics between wood and electric heating for these facilities would have to be carried out.

5.4.5.4 Energy Use Data Tables for Carmacks

TABLE 5-25a

YTG & MUNICIPAL BUILDINGS ENERGY USE: CARMACKS
SOURCE: YTG Energy Branch, YTG Supply Services Branch, YECL

#	DESCRIPTION	83-4 FUEL EST LTR*1000	82-3 ELEC MWH	82-3 FUEL LITRES	81-2 ELEC MWH	81-2 FUEL GAL	80-1 ELEC MWH	80-1 FUEL GAL
511	School & Techrg	39	144	83265	82	12036	50	6582
512	Grader Sta	30	18	24519	20	5222		3264
518	Bldg Maint Shop	12						
519	Firehall (M)		4	4995				
	LID Ofc (M)			2428				
	Pool (M)		8	2487				
	Sewage Trtmt (M)		30					
	Tfk & St Lights		177		168		114	
	TOTAL	81	381	117694	270	17258	164	9846

MUNICIPAL GOVT BUILDINGS: 5 ... Curling rink

BAND COUNCIL BUILDINGS: Band Ofc, Rec Hall, Garage, Washouse

#	DESCRIPTION	80-1 ELEC GJ	81-2 ELEC GJ	82-3 ELEC GJ	AVG 80-3 ELEC GJ	80-1 FUEL GJ	81-2 FUEL GJ	82-3 FUEL GJ	AVG 80-3 FUEL GJ	AVG FUEL GJ	EST 83-4 FUEL GJ
511	School & Techrg	181	294	518	331	1180	2158	3289	2209	1867	1525
512	Grader Sta		72	65	68	585	936	969	830	1008	1185
518	Bldg Maint Shop									474	474
519	Firehall (M)			16	16			197	197	197	
	LID Ofc (M)							96	96	96	
	Pool (M) propane			29	29			67	67	67	
	Sewage Trtmt (M)			107	107						
	Tfk & St Lights	410	604	638	551						
	TOTAL				1102				3400	3709	3184
	AVG w/o school, grader stn, st lights			MWH:	14			GJ:	120	209	474

TABLE 5-25b

GOVERNMENT FUEL REQUIREMENTS ESTIMATES - 1983-84
SOURCE: YTG Supply & Services, Fed. Govt. Supply & Services
Data in Litres X 1000

Community	YTG Bldgs	Education	Fed. Govt.	F.G. Res.
Carmacks	30	39	14	6
	12		32	
			44	
Total Litres:	42	39	90	6
Total # bldgs	3	1	9	5
GJ:	1659	1525	3559	217
Total Govt.:	5218			
GJ per Bldg.:	553	1525	395	43

TABLE 5-25c

RCMP BUILDINGS - ENERGY USE: CARMACKS
SOURCE - RCMP, Whitehorse

DESCRIPTION	VOL (M3)	81-82 LITRES	MJ/DDY	82-83 LITRES	MJ/DDY	82-83 MWH	AVG YR GJ	KJ/M3 /DDY	RPI	83-4 FUEL EST litres	GJ
CARMACKS		DDY=	8097	DDY=	8016		7970				
Detachment	778	4698	23	5471	27	N/A	199	32	6	31900	1260
att baraks/ofc	207	2904	14	1963	10	N/A	95	58	5		0
MQ compound	271	3917	19	3621	18	N/A	147	68	10		0
PC storage	286	4720	23	1431	7	N/A	120	53	6		0
storage/wrkshp	228	2866	14	2026	10	N/A	95	53	5		0
AVERAGE	354	3821	19	2902	14	N/A	131	53	7		
TOTAL	1769	19105	93	14512	72	N/A	656	47		31900	1260 1.92

TABLE 5-25d

COMMERCIAL BUILDING ENERGY USE: CARMACKS
SOURCE: YTG Energy Branch Commercial Energy Audits

BUILDING	VOLUME M3	ELEC MWH	PERIOD	FUEL LITRES	PERIOD	DDY	FUEL GJ	MJ/M3	AVG YR GJ	KJ/M3 /DDY	RPI
									7970		
N.W.TEL	241	17	204.303	2993	204.302	5827	118	491	162	84	14 **

TABLE 5-25e

COMMERCIAL ELECTRICITY: CARMACKS
SOURCE:YTG Econ Devt Branch
Yukon Business Directory, NorthwesTel Directory

COMMERCIAL BUILDING	82-83 MWH	ELEC GJ	$/MWH	IC
GENERAL STORE	21.06	76	13.1	1 J60
COMMUNITY CLUB	12.34	44	16.3	1 N33
				2 J63
				1 J65
				5 F42
				3 Q91
				1 Q92
				1 R96
				1 R98
				1 H48
				1 G49

AVERAGE MWH 16.70
AVG $/MWH 14.7
TOTAL MWH 33

OTHER COMML USERS: 16

TOTAL COMML USERS: 18

TABLE 5-25f

YUKON HOUSING RENTAL UNITS: CARMACKS
SOURCE: YTG Energy Branch, Yukon Housing Corp

BUILDING	YEAR	VOLUME M3	80-81 LITRES	MJ/DDY	81-82 LITRES	MJ/DDY	81-82 ELEC KWH	AVG YR GJ	KJ/M3 /DDY	RPI *******
CARMACKS DDY				7019		8097		7970		
bi-level split entry	68	602	3677	21	4299	21	859	166	35	6
		602	3582	20	3995	19	24126	158	33	5
		602	5103	29	4377	21		200	42	8 *
		602	5162	29	5507	27	10295	223	46	10 *
AVERAGE		602	4121	23	4224	21	12493	175	36	6
bilevel split entry	74	355	2842	16	3055	15		123	44	5
		355	2420	14	3046	15		113	40	5
		355	4168	23	3573	17		163	58	9 *
		355	3260	18	2620	13		124	44	5
AVERAGE		355	3172	18	3074	15		131	46	6
modular dbl. wide	73	488	4013	23	4249	21	14827	173	44	8
		488	3950	22	4345	21	6755	173	45	8 *
		488	3482	20	3882	19	6365	154	40	6
		488	3351	19	4240	21	3374	158	41	6
		488	4054	23	4445	22	17198	177	46	8 *
		488	3850	22	3768	18	13788	160	41	7 *
		488	3550	20	3450	17	16022	147	38	6
		488	3882	22	4304	21	13036	171	44	8 *
		488	4899	28	3623	18	12740	180	46	8 *
		488	3703	21	3814	19	12579	157	40	6
AVERAGE		488	3873	22	4012	20	11668	165	42	7 *
bilevel split entry	75	434	3691	21	3750	18	11359	156	45	7 *
		434	3541	20	3523	17	16545	148	43	6
		434	3741	21	3305	16	12652	148	43	6
		434	4154	23	3982	19	5650	171	49	8 *
		434	3596	20	3301	16	5622	145	42	6
AVERAGE		434	3745	21	3572	17	10366	153	44	7 *
TOTAL AVERAGE		472	3799	21	3827	19	11349	160	43	7

TABLE 5-25g

GOVERNMENT OF CANADA HEATING ASSISTANCE PAYMENTS: CARMACKS
SOURCE:YTG Dept. of Finance
PERIOD:1 Ap82-31 Mr83 MAX $/LITRE: .44

TYPE	Wd	AREA	VOLUME M3	PERIOD	LITRES	GJ	MJ/M3	AVG YR GJ	KJ/M3 /DDY	RPI *******
CARMACKS			DDY50-80=	7970		DDY82-83=	8016			
YHCS F		936	212	210. 303	3152	125	587	124	73	9 *
YHC5 F		2656	602	210. 303	4314	170	283	169	35	6
YHC5 F		1564	355	210. 203	2560	101	285	101	36	4
PVT,	+	1500	340	204. 302	1144	45	133	52	19	1
PVT,		1200	272	821215	3213	127	467	126	58	7 *
PVT,		1800	408	204. 303	3108	123	301	122	38	5
PVT,	+	1100	249	210. 211	1530	60	242	141	71	10 *
AVERAGE		1537	348		2717	107	328	119	47	6

5.4.6 Haines Junction

5.4.6.1 Cultural and Economic Setting

Situated on the north bank of the Dezadeash River, Haines Junction lies at the intersection of the Alaska Highway and the road south to Haines, Alaska. It is the headquarters for Kluane National Park, one of the largest national parks in Canada (25,888 km^2). Although Haines Junction was not established until after World War II, the area was subject to considerable human movement because of major trading routes linking the coast to the interior which traversed the area. Originally a predominantly non-Indian community in the 1940's to 1950's, more Indians moved into the community after DINA centralized housing in Haines Junction.

5.4.6.2 Community Energy Planning for Haines Junction

If the community of Haines Junction wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Haines Junction.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Haines Junction, then the estimated space heating load of 50000 Gigajoules could be reduced by 50 percent to 25000 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Haines Junction, the other sector which uses a large proportional amount of energy for space heating is the Yukon and Municipal Government sector. Yukon and Municipal Government buildings consume 13 percent of the space heating fuel and comprise only 6 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public buildings will offer the most favorable conservation/ retrofit opportunities.

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementation of energy conservation. People from communities throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to

TABLE 5-26

COMMUNITY ENERGY PROFILE: HAINES JUNCTION POPULATION: 460

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL SPHT GJ	%	TOTAL GJ	%
FED GOVERNMENT	38	14	15	570	18	181	6877	14	8927	15
YUKON & MUNICPL GOVT	16	6	15	240	8	400	6400	13	7263	12
EDUCATION	2	1	138	276	9	2056	4112	8	5106	8
COMMERCIAL	41	15	17	714	22	200	8200	16	10767	17
FED GOVT RESIDENTIAL	32	12	14	448	14	120	3840	8	5452	9
YUKON HSG CORP	21	8	14	302	9	132	2772	6	3860	6
RESIDENTIAL	39	14	5	199	6	110	4290	9	5008	8
RESIDENTIAL (ttl wd)	88	32	5	450	14	154	13552	27	15171	25
TOTAL	277			3200			50043		61554	
TOTAL RESIDENTIAL	180			1400						

GJ USED PERCAPITA 134

kWh/litre gen eff: GRID

TOTAL GJ INPUT: 61554

GJ INPUT PERCAPITA 134

energy conservation. Beginning in 1984, Yukon College, through the Education Extension Program will offer courses in Haines Junction for those who are interest in retrofit technology, energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved. This will result in reductions of oil use, both through direct space heating and energy requirements for fuel transport. Residential buildings sampled in Haines Junction for this study, indicate retrofit potential indices (RPI) as high as 28. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in Haines Junction and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load ranges from 110 to 154 Gigajoules per household. The lower figure undoubtably reflects seasonal occupation of the houses and/or the utilization of wood as a supplementary heating fuel. The upper figure represents totally wood heated households. Three factors contribute to this high value. Firstly, the typical inefficiency of most wood burning appliances, secondly, the inaccuracy of estimated "cord" value, and thirdly, the residences which use wood as the primary heating source are generally less thermally efficient than other residences in the community.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

Since Haines Junction is connected to the hydroelectric power grid, electricity is an available renewable resource which could be used for space heating. However, since electricity supplies higher grade energy requirements which cannot be feasibly provided by fuel, then it may be more prudent to utilize electricity to sustain the desired level of economic development, than to use it as an alternative source for space heating. Only those buildings which meet the recommendations for the upcoming Northern Building Energy Standards (NRC-DBR) can be considered as viable candidates for electrical space heating.

Another renewable energy supply option which would be more favorable than hydro-electric power for space heating in Haines Junction is the efficient utilization of wood as a space heating fuel, and a well organized fuel wood delivery system.

Other energy supply options for Haines Junction are discussed in the following sections.

5.4.6.2 Energy Supply Alternatives

(a) Wood

Wood use could be increased in Haines Junction, with individual building space heating being the most practical application. For residential buildings, wood burning stoves would be suitable while wood fired boilers are feasible for larger buildings with hydronic systems.

No major fire-killed forest areas were identified in the Haines area but reasonably good live forest is accessible. See Section 5.1.2 for generl comments on wood use.

(b) Hydro

Being on the grid, the situation in Haines is similar to that in Whitehorse where future electric useage patterns depend on whether surplus electric power is available. As in Whitehorse, large buildings may find it economic to go off oil to use electric energy for space heating as long as the necessary supply is assured. See the general comments on grid capacity in Section 5.1.2.

(c) Geothermal/Heat Pumps

Previous studies have indicated the possibility of some low temperature geothermal resources in the Haines area. Certainly, if any warm subterranean water is evident, application of heat pumps can be very attractive economically. Refer to the comments on heat pumps in Section 5.1.2.

There appears to be no known source of geothermal energy close to the community which would be suitable for direct heating or for electrical generation.

5.4.6.4 Energy Use Data Tables for Haines Junction

TABLE 5-27a

YTG & MUNICIPAL BUILDINGS ENERGY USE: HAINES JUNCTION
SOURCE: YTG Energy Branch, YTG Supply Services Branch, YECL

#	DESCRIPTION	83-4 FUEL EST LTR*1000	82-3 ELEC MWH	82-3 FUEL LITRES	81-2 ELEC MWH	81-2 FUEL GAL	80-1 ELEC MWH	80-1 FUEL GAL
405	School	104	244	73191	331	24879	254	25005
420	Grader Sta	40	58	36433	67	10308		7542
413	Bldg Maint Shop	18				829		3572
417	Admin Bldg	15	112		31	1113		8707
410	Weigh Sc Tourist Inf	6			13	1276		1360
421	Freezer Str/Pumphse	10	4	4829	4	868		1033
423	Wildlf Br Garage	7						
421	Camp bldgs				10			
	Truck Plugs				5			
	Band Ofc			9626				
	Wash House/Laundry			8895				
	Tfk & St Lights		131		112		92	
	TOTAL	200	550	132974	572	39273	346	47219

MUNICIPAL GOVT BUILDINGS: Community Hall, Hockey Rink, Curling Rink, Pool

BAND COUNCIL BUILDINGS: Band Ofc, Community hall, Washhouse/Laundry, Curling Rink, Sr Ctz Home

#	DESCRIPTION	80-1 ELEC GJ	81-2 ELEC GJ	82-3 ELEC GJ	AVG 80-3 ELEC GJ	80-1 FUEL GJ	81-2 FUEL GJ	82-3 FUEL GJ	AVG 80-3 FUEL GJ	AVG FUEL GJ	EST 83-4 FUEL GJ
405	School	915	1192	878	995	4484	4462	2891	3946	4029	4112
420	Grader Sta		240	208	224	1353	1849	1439	1547	1563	1580
413	Bldg Maint Shop					641	149		395	553	711
417	Admin Bldg		112	404	258	1561	200		881	737	593
410	Weigh Sc Tourist Inf		48		48	244	229		236	233	229
421	Freezer Str/Pumphse		13	16	15	185	156	191	177	286	395
423	Wildlf Br Garage									269	269
421	Camp bldgs		36		36						
	Truck Plugs		16		16						
	Band Ofc							380	380	380	
	Wash House/Laundry							351	351	351	
	Tfk & St Lights	331	402	472	401						
	TOTAL				1993				7913	8400	7888
	AVG w/o school, grader stn, st lights			MWH:	21			GJ:	403	401	439

TABLE 5-27b

GOVERNMENT FUEL REQUIREMENTS ESTIMATES - 1983-84
SOURCE: YTG Supply & Services, Fed. Govt. Supply & Services
Data in Litres X 1000

Community	YTG Bldgs	Education	Fed. Govt.	F.G. Res.
H.Junction	15	104	16	97
	18		23	
	40		9	
	10		44	
	7		82	
	6			
Total Litres:	96	104	174	97
Total # bldgs	7	2	38	32
GJ:	3776	4112	6877	3832
Total Govt.:	10653			
GJ per Bldg.:	539	2056	181	120

TABLE 5-27c

RCMP BUILDINGS - ENERGY USE: HAINES JUNCTION
SOURCE - RCMP, Whitehorse

DESCRIPTION	VOL (M3)	81-82 LITRES	MJ/DDY	82-83 LITRES	MJ/DDY	82-83 MWH	AVG YR GJ	KJ/M3 /DDY	RPI	83-4 FUEL EST litres	GJ
HAINES JUNCTION		DDY=	8046	DDY=	7707		7699				
Detachment	901	3650	18	3600	18		140	20	3	31900	1260
?	240			677	3	7	27	14			
temp office	240					15					
residence	240	882	4	882	5	22	34	18	1		
residence	240			439	2	21	17	9			
MQ	391					16					
AVERAGE	375	2266	4	1400	5	16	36	11	1		
TOTAL	2252	4532	22	5598	29	80	196	11		31900	1260
											6.43

TABLE 5-27d

COMMERCIAL ELECTRICITY: HAINES JUNCTION
SOURCE:YTG Econ Devt Branch
Yukon Business Directory, NorthwesTel Directory

	82-83 MWH	ELEC GJ	$/MWH	#	IC
INN	55.08	198	14.3	1	Q91
INN	103.44	372	14.4	1	Q91
STORE	46.26	167	10.5	1	J60
LODGE	60.60	218	14.1	1	Q91
COMM CLUB	26.96	97	13.4	1	R96
				4	Q91
				1	Q92
				1	R96
				5	R98
				3	R99
				4	F40
				3	F42
				2	G45
				1	J60
				1	J62
				1	J63
				2	J69
				1	E10
				3	N83
				1	O85
				1	K70
				1	H48
				1	G49

AVG MWH	58.47		
		AVG $/MWH	13.34
TOTAL MWH	292		
OTHER COM	36		
TOTAL COM	41		

TABLE 5-27e

COMMERCIAL BUILDING ENERGY USE: HAINES JUNCTION
SOURCE: YTG Energy Branch Commercial Energy Audits

BUILDING	VOLUME M3	ELEC MWH	PERIOD	FUEL LITRES	PERIOD	DDY	FUEL GJ	MJ/DDY	AVG YR GJ	KJ/M3 /DDY	RPI
									7699		
MOTEL Stardust	680	12	102.201	11577	yrly est	7699	457	59	457	87	40

TABLE 5-27f

YUKON HOUSING RENTAL UNITS: HAINES JUNCTION
SOURCE: YTG Energy Branch, Yukon Housing Corp

BUILDING	YEAR	VOLUME M3	80-81 LITRES	MJ/DDY	81-82 LITRES	MJ/DDY	81-82 ELEC KWH	AVG YR GJ	KJ/M3 /DDY	RPI	*******
HAINES JUNCTION				6916		8046		7699			
modular dbl.wide	81	334			2642	13		100	39	4	
3 bdrm. detatched	81	540			3078	15		116	28	3	
	81	434			3437	17		130	39	5	
	81	434			3019	15		114	34	4	
	81	434			2792	14		106	32	3	
	81	528			1647	8		62	15	1	
	81	528			2107	10		80	20	2	
3 bdrm detached	72	212	3269	19	3945	19	17803	146	90	13	**
	72	212	2538	14	3414	17	14265	120	74	9	*
	72	212	2638	15	3305	16	12343	120	74	9	*
	72	212	5416	31	4999	25	23384	214	131	28	****
	72	212	4354	25	3455	17	6689	161	99	16	**
	72	212	3019	17	3473	17	8881	132	81	11	*
	72	212	3614	21	4354	21	13301	162	99	16	**
	72	212	3205	18	3341	16	16280	134	82	11	*
	72	212	2384	14	3010	15	18421	109	67	7	*
AVERAGE		212	3382	19	3700	18	14596	144	98	13	*
bilevel split entry	75	355	2179	12	2810	14	19048	101	37	4	
	75	355	3541	20	3777	19	12622	149	55	9	*
	75	355	2379	14	3146	15	14732	112	41	5	
	75	355	3124	18	3459	17	12287	134	49	7	*
	75	355	2729	16	3564	17	11388	127	47	6	
AVERAGE		355	2790	16	3351	16	14015	125	46	6	
TOTAL AVERAGE		325	3160	18	3297	16	14378	132	53	9	*

TABLE 5-27g

GOVERNMENT OF CANADA HEATING ASSISTANCE PAYMENTS: HAINES JUNCTION
SOURCE:YTG Dept. of Finance
PERIOD:1 Ap82-31 Mr83 MAX $/LITRE: .421

TYPE	AREA	VOLUME M3	PERIOD	LITRES	GJ	MJ/DDY	AVG YR GJ	KJ/M3 /DDY	RPI *******
HAINES JUNCTION		DDY50-80=	7699		DDY82-83=	7707			
CHUR	1100	249	204.212	2508	99	13	99	52	5
RPVT	1660	376	210.301	957	38	8	62	22	1
PVT,	1512	343	212.303	2077	82	11	82	31	3
PVT,	1256	285	211.303	2976	118	15	117	54	6
PVT,	1100	249	302.303	705	28	16	121	63	8 *
PVT,	1400	317	204.303	3912	155	20	154	63	10 *
PVT,	1000	227	204.303	3224	127	17	127	73	9 *
AVERAGE	1424	292		2337	92	14	109	51	6

5.4.7 Johnsons Crossing

5.4.7.1 Cultural and Economic Setting

Johnsons Crossing is a small community with about 10 households and a highway lodge. This community is not included in available social profile information.

5.4.7.2 Community Energy Planning for Johnsons Crossing

If the community of Johnsons Crossing wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Johnsons Crossing.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Johnsons Crossing, then the estimated space heating load of 1700 Gigajoules could be reduced by 50 percent to 950 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Johnsons Crossing, the other sector which uses a large proportional amount of energy for space heating is the Commercial sector. Commercial buildings consume 17 percent of the space heating fuel and comprise only 14 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public buildings will offer the most favorable conservation/retrofit opportunities.

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementation of energy conservation. People from communities throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to energy conservation. Beginning in 1984, Yukon College, through the Education Extension Program will offer courses in Johnsons Crossing for those who are interest in retrofit technology, energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved. This will result in reductions of oil use, both through direct space heating and energy requirements for fuel

TABLE 5-28

COMMUNITY ENERGY PROFILE: JOHNSON'S CROSSING POPULATION: 10

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL SPHT GJ	%	TOTAL GJ	%
FED GOVERNMENT										
YUKON & MUNICPL GOVT										
EDUCATION										
COMMERCIAL	1	14	18	18	55	300	300	17	365	20
FED GOVT RESIDENTIAL										
YUKON HSG CORP										
RESIDENTIAL										
RESIDENTIAL (ttl wd)	6	86	3	15	45	238	1428	83	1482	80
TOTAL	7			33			1728		1847	
TOTAL RESIDENTIAL	6			15		GJ USED PERCAPITA			185	
	kWh/litre gen eff:		.72	1799	GJ	TOTAL GJ INPUT:			3527	
						GJ INPUT PERCAPITA			353	

transport. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in Johnsons Crossing and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load is 238 Gigajoules per household. This high figure represents totally wood heated households. Three factors contribute to this high value. Firstly, the typical inefficiency of most wood burning appliances, secondly, the inaccuracy of estimated "cord" value, and thirdly, the residences which use wood as the primary heating source are generally less thermally efficient than other residences in the community.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

The diesel fueled electric generator in Johnsons Crossing uses an estimated 1800 Gigajoules per year. It may be possible to recover much of this energy as available waste heat. After conservation, the net space heating load of 950 Gigajoules could be further offset by the recovery of waste heat from the generator. This available energy should be specifically evaluated in terms of identifying buildings which have sufficiently high heating demands, and are close enough to the power plant to make heat transmission effective.

Other energy supply options for Johnsons Crossing are discussed in the following sections.

5.4.7.3 Energy Supply Alternatives

(a) Hydro

The diesel generator at Johnsons Crossing is possibly the most inefficient in the Yukon, resulting in the highest specific consumption of diesel fuel, at about 1.3 liters per kWh. Johnsons Crossing is not large enough to provide sufficient demand to justify any hydro development or grid extension on its own. It may be in the fortuitous position, however, of being in the right area if hydro is developed for Teslin or for connection back to the central grid. Squanga Creek, just west of Johnson Crossing, has been examined by NCPC with this in mind. About 1.5 MW of installed capacity is apparently available here.

Close to 33,000 litres of diesel fuel were consumed in 1981/82 to produce just 24,000 kWh in Johnsons Crossing. This works out to a fuel cost alone of about 58¢ per kWh. Part of the problem is the large size of diesel plant installed for the load. In fact, the load factor is only 18%. With a peak load of only 18 kW, the installed capacity is closer to 30 kW. As a result, losses in the system amount to about 18,000 kWh per year, or 37.5% of the generation. Downsizing the diesel set should be considered.

(b) Heat Recovery

If the diesel is going to continue to operate, heat recovery at least to the lodge should be installed. The available heat energy from such a system would be of the order of 410 GJ which should be more than adequate for the commercial heating demand in the community. See Section 5.1.2 for further comments.

5.4.7.4 Energy Data Tables for Johnsons Crossing and Other Highway Lodges

TABLE 4-29a

COMMERCIAL BUILDING ENERGY USE: LODGES
SOURCE: YTG Energy Branch Commercial Energy Audits

BUILDING	VOLUME M3	ELEC MWH	PERIOD	FUEL LITRES	PERIOD	DDY	FUEL GJ	MJ /DDY	AVG YR GJ	KJ/M3 /DDY	RPI
						7699					
LODGE Dezadeash Cafe	580			25	CDS/yr	7699	350	45	350	78	27
LODGE Dezadeash Mote	748			20430	yr	7699	807	105	807	140	113
POWER Generator		101@	28% eff	32688	yr	7699	1291		1291		
TOTAL	1328	101		53118			2448		2448		
						10200					
LODGE Eagle Plains	7283			47897	yr	10200	1892	185	1892	25	48
GARAGE Eagle Plains	4217			47443		10200	1874	184	1874	44	82
POWER Generator		516@	28% eff	167980		10200	6635		6635		
TOTAL	11500	516		215423			10401		10401		
LODGE Morley River	816	7	yr	16971	yr	7213	670	93	670	114	76

TABLE 5-29b

GOVERNMENT OF CANADA HEATING ASSISTANCE PAYMENTS
SOURCE:YTG Dept. of Finance
PERIOD:1 Ap82-31 Mr83

TYPE	AREA	VOLUME M3	PERIOD	LITRES	GJ	MJ/DDY	AVG YR GJ	KJ/M3 /DDY	RPI
						7707	7699		
LODG	4000	907	820903	4500	178	23			
mile 1022 AKHY			821125	4550	180	23			
			830301	912	36	5			
		907		9962	393	51	393	56	22

5.4.8 Old Crow

5.4.8.1 Cultural and Economic Setting

Old Crow is Yukon's northernmost settlement. It is located at the junction of the Old Crow and Porcupine Rivers. Old Crow is claimed as one of the oldest human habitations in North America; archaeological evidence suggests that people lived on Old Crow Flats about 30,000 years ago.

The present day site of Old Crow is a good fishing area near major spring caribou migration routes and had been a gathering place for families going down the Porcupine River to trade. Until the 1950's, people wintered in small camps along the Porcupine River. Around this time a federal day school was built and Old Crow became a year round headquarters. The settlement extends 1,000 m along the north shore of the river. Eighty-five percent of the inhabitants are Native. Residents either hunt, fish and trap or work for the territorial government.

Old Crow provides community services to the residents and also attracts a small tourist industry.

5.4.8.2 Community Energy Planning for Old Crow

If the community of Old Crow wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Old Crow.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Old Crow, then the estimated space heating load of 21000 Gigajoules could be reduced by 50 percent to 10500 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Old Crow, the other sector which uses a large proportional amount of energy for space heating is the Yukon and Municipal Government sector. Yukon and Municipal Government buildings consume 8 percent of the space heating fuel and comprise only 6 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public

TABLE 5-30

COMMUNITY ENERGY PROFILE: OLD CROW POPULATION: 243

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL SPHT GJ	%	TOTAL GJ	%
FED GOVERNMENT	14	11	14	196	28	143	2000	10	2705	12
YUKON & MUNICPL GOVT	8	6	14	112	16	200	1600	8	2003	9
EDUCATION	1	1	64	64	9	2800	2800	13	3030	13
COMMERCIAL	7	6	14	98	14	200	1400	7	1753	8
FED GOVT RESIDENTIAL	1	1	8	8	1	156	156	1	185	1
YUKON HSG CORP										
RESIDENTIAL	9	7	2	21	3	110	990	5	1066	5
RESIDENTIAL (ttl wd)	85	68	2	201	29	140	11900	57	12622	54
TOTAL	125			700			20846		23364	
TOTAL RESIDENTIAL	95			230			GJ USED PERCAPITA		96	
	kWh/litre gen eff: 2.76			10018 GJ			TOTAL GJ INPUT:		30864	
							GJ INPUT PERCAPITA		127	

buildings will offer the most favorable conservation/ retrofit opportunities.

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementation of energy conservation. People from communities throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to energy conservation. Beginning in 1984, Yukon College, through the Education Extension Program will offer courses in Old Crow for those who are interest in retrofit technology, energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved. This will result in reductions of oil use, both through direct space heating and energy requirements for fuel transport. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in Old Crow and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load ranges from 110 to 140 Gigajoules per household. The lower figure undoubtably reflects seasonal occupation of the houses and/or the utilization of wood as a supplementary heating fuel. The upper figure represents totally wood heated households. Three factors contribute to this high value. Firstly, the typical inefficiency of most wood burning appliances, secondly, the inaccuracy of estimated "cord" value, and thirdly, the residences which use wood as the primary heating source are generally less thermally efficient than other residences in the community.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

The diesel fueled electric generator in Old Crow uses an estimated 10000 Gigajoules per year. It may be possible to recover much of this energy as available waste heat. After conservation, the net space heating load of 10500 Gigajoules could be further offset by the recovery of waste heat from the generator. This available energy should be specifically evaluated in terms of identifying buildings which have sufficiently high heating demands, and are close enough to the power plant to make heat transmission effective.

Other energy supply options for Old Crow are discussed in the following sections.

5.4.8.3 Energy Supply Alternatives

(a) Wood

Old Crow residents already make ample use of wood both for residential heating and school heating. Two hundred cords are used annually in the school and the estimated use per household is about 10 cords per year. At this rate, it must be assumed that the bulk of the oil used in the community is applied to heating government and commercial buildings, and to diesel generation of electricity.

Given the high delivered costs of oil in Old Crow, there is substantial incentive to seek ways to find alternatives for oil in both space heating and power generation. Wood is the only abundant alternative fuel. There is a large firekill area of some 172,000 hectares east of the community along the Porcupine River. While the wood density is only modest, the size of the area compensates. Wood is transported to Old Crow via the river.

Every effort should be made to convert to wood those buildings using oil for space heating to wood. This possibly involves removing government subsidies on oil and providing corresponding incentives to use wood. That is, financial incentives could be given to the Band to expand their wood collection program so that they would be compensated for stockpiling wood for non-band buildings.

The Old Crow community is physically clustered fairly closely together, so that a central, wood fired district heating system to supply some of the major buildings may be possible. The viability of such a plan should be investigated. A spinoff effect of such wood use is that local employment would be provided and more dollars would be retained in the community. For further comments on community wood use, see Section 5.1.2

(b) Heat Recovery

Whether the diesel is replaced or not, heat recovery should be utilized as much as possible. It is probably even justified to relocate the diesel sets closer to the major oil heated buildings, if necessary. If the diesels are replaced by wood-fired generation, then certainly these facilities should be located so as to take maximum advantage of waste heat, also. See the general comments on heat recovery in Section 5.1.2.

5.4.8.4 Energy Data Tables for Old Crow

TABLE 5-31a

YTG & MUNICIPAL BUILDINGS ENERGY USE: OLD CROW
SOURCE: YTG Energy Branch, YTG Supply Services Branch, YECL

#	DESCRIPTION	83-4 FUEL EST LTR*1000	82-3 ELEC MWH	82-3 FUEL LITRES	81-2 ELEC MWH	81-2 FUEL GAL	80-1 ELEC MWH	80-1 FUEL GAL
649	Chief Gittlit Sch		64	$15971wd	77		75	
650	Teachers Apt		17		20			
646	Foreman's Quarters		17					
647	Buldozer shed							
648	Pallatizer shed							
651	Ice House							
652	POL Stor							
653	Airport Garage		37		54			
654	Airport Terminal		20		25			
	Runway lights		12		16			
	Beacon		18		75			
	Tfk & St Lights		72		73		48	
	TOTAL		259		340		123	

MUNICIPAL GOVT BUILDINGS:

BAND COUNCIL BUILDINGS: Band ofc, Co-op store, Warehouse/workshop

#	DESCRIPTION	80-1 ELEC GJ	81-2 ELEC GJ	82-3 ELEC GJ	AVG 80-3 ELEC GJ	80-1 FUEL GJ	81-2 FUEL GJ	82-3 FUEL GJ	AVG 80-3 FUEL GJ	AVG FUEL GJ	EST 83-4 FUEL GJ
649	Chief Gittlit Sch	271	277	231	260			2800	2800	2800	
650	Teachers Apt		73	60	67						
646	Foreman's Quarters			63	63						
647	Buldozer shed										
648	Pallatizer shed										
651	Ice House										
652	POL Stor										
653	Airport Garage		194	134	164						
654	Airport Terminal		89	72	81						
	Runway lights		57	45	51						
	Beacon		270	67	168						
	Tfk & St Lights	171	264	260	232						
	TOTAL				1085				2800	2800	
	AVG w/o school, grader stn, st lights			MWH:	29			GJ:	2800	2800	

TABLE 5-31b

GOVERNMENT FUEL REQUIREMENTS ESTIMATES - 1983-84
SOURCE: YTG Supply & Services, Fed. Govt. Supply & Services
Data in Litres X 1000

Community	YTG Bldgs	Education	Fed. Govt.	Type	#	M2	MJ/M3	KJ/M3 /DDY	F.G. Res.	AREA M2
Old Crow			27	RCM OPR	6	391	983	96	4	66
			3	NHW OPR	2	49				
			12	NHW INS	1	198				
			6	IAN ADM	1	107				
			2	IAN INS	1	36				
			7	IAN OPR	2	113				
			5	DPW ADM	1	79				
Total Litres:			51						4	
Total # bldgs	3	1	14			973			1	
GJ:			1999						156	
Total Govt.:	1999									
GJ per Bldg.:			143						156	

(based on estimates for RCMP)

TABLE 5-31c

RCMP BUILDINGS - ENERGY USE: OLD CROW
SOURCE - RCMP, Whitehorse

DESCRIPTION	VOL (M3)	81-82 LITRES	MJ/DDY	82-83 LITRES	MJ/DDY	82-83 MWH	AVG YR GJ	KJ/M3 /DDY	RPI	83-4 FUEL EST litres	GJ
OLD CROW		DDY=	9240	DDY=	10073		10207				
Det/quarters	940					28.5				27300	1078

TABLE 5-31d

COMMERCIAL ELECTRICITY: OLD CROW
SOURCE:YTG Econ Devt Branch
Yukon Business Directory, NorthwesTel Directory

COMMERCIAL BUILDING	82-83 MWH	ELEC GJ	$/MWH	#	IC
GNL STORE, Old Crow	24.00	86	38	1	J64,159
			(2)		N83
				1	Q92
				2	R98
				1	H48
				1	G45
				1	G49
				1	D7

AVERAGE MWH	24.00
TOTAL MWH	24
OTHER COMML USERS:	6
TOTAL COMML USERS:	7

TABLE 5-31e

COMMERCIAL BUILDING ENERGY USE: OLD CROW
SOURCE: YTG Energy Branch Commercial Energy Audits

BUILDING	VOLUME M3	ELEC MWH	PERIOD	FUEL LITRES	PERIOD	DDY	FUEL GJ	MJ/DDY	AVG YR GJ	KJ/M3 /DDY	RPI
									10207		
STORE Co-op	1217	24	1980 est	16344	avg yr	10207	646	63	646	52	34

5.4.9 Pelly Crossing

5.4.9.1 Cultural and Economic Setting

Located on the Klondike Highway midway between Whitehorse and Dawson City, Pelly Crossing is a recent community built by the federal government for the Indians in the 1950's. Earlier attempts at settlement in the area by others (in 1948) were thwarted when the Chilkat Indians burned a trading post. This was the only settlement in the Yukon ever destroyed by Indians. Eighty-five percent of the present population is native, who rely mostly on temporary jobs in hunting and fishing for livelihood.

5.4.9.2 Community Energy Planning for Pelly Crossing

If the community of Pelly Crossing wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Pelly Crossing.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Pelly Crossing, then the estimated space heating load of 12000 Gigajoules could be reduced by 50 percent to 6000 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Pelly Crossing, the other sector which uses a large proportional amount of energy for space heating is the Commercial sector. Commercial buildings consume 11 percent of the space heating fuel and comprise only 9 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public buildings will offer the most favorable conservation/ retrofit opportunities.

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementation of energy conservation. People from communities throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to energy conservation. Beginning in 1984, Yukon College, through the Education Extension Program will offer courses in Pelly Crossing for those who are interest in retrofit

TABLE 5-32

COMMUNITY ENERGY PROFILE: PELLY CROSSING POPULATION: 182

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL SPHT GJ	%	TOTAL GJ	%
FED GOVERNMENT	2	3	24	48	7	200	400	3	573	4
YUKON & MUNICPL GOVT	5	8	24	120	18	186	932	8	1363	10
EDUCATION	2	3	45	90	13	612	1223	11	1547	11
COMMERCIAL	6	9	27	162	24	216	1296	11	1879	13
FED GOVT RESIDENTIAL										
YUKON HSG CORP	7	11	18	129	19	158	1106	10	1569	11
RESIDENTIAL			3							
RESIDENTIAL (ttl wd)	43	66	3	131	19	154	6622	57	7094	51
TOTAL	65			680			11579		14025	
TOTAL RESIDENTIAL	50			260		GJ USED PERCAPITA			77	
	kWh/litre gen eff: 2.60			10331 GJ		TOTAL GJ INPUT:			21909	
						GJ INPUT PERCAPITA			120	

technology, energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved. This will result in reductions of oil use, both through direct space heating and energy requirements for fuel transport. Residential buildings sampled in Pelly Crossing for this study, indicate retrofit potential indices (RPI) as high as 15. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in Pelly Crossing and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load is 154 Gigajoules per household. Three factors contribute to this high value. Firstly, the typical inefficiency of most wood burning appliances, secondly, the inaccuracy of estimated "cord" value, and thirdly, the residences which use wood as the primary heating source are generally less thermally efficient than other residences in the community.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

The diesel fueled electric generator in Pelly Crossing uses an estimated 10000 Gigajoules per year. It may be possible to recover much of this energy as available waste heat. After conservation, the net space heating load of 6000 Gigajoules could be further offset by the recovery of waste heat from the generator. This available energy should be specifically evaluated in terms of identifying buildings which have sufficiently high heating demands, and are close enough to the power plant to make heat transmission effective.

Other energy supply options for Pelly Crossing are discussed in the following sections.

5.4.9.3 Energy Supply Alternatives

(a) Wood

The most immediate objective in Pelly Crossing should be to train and certify operators on the existing wood-chip school heating system and to get that operation running smoothly. Once this is done, other applications of the same technology could be considered. This is especially attractive since it is understood that the chipper in use there has substantially more capacity than is required for the school alone.

There appears to be an abundant supply of fire-killed wood in the Pelly area. With native households already using some 10-12 cords each, it is probable that very little oil is being used for residential space heating. Wherever it is, however, conversion to wood should be considered.

General comments on wood use for electrical generation through gasification or low pressure steam are provided in Section 5.1.2

(b) Hydro

The study search for small hydro potential indicated a possible site for a 860 kW installation on Ptarmigan Creek, about 17 km. from the community. This preliminary work, however, indicates a very long penstock (7,000 meters) which may preclude its feasibility on economic grounds.

The Pelly River and some of its major tributaries have already been previously examined for large scale hydro developments. If any of these are developed, they would be designed for connection to the grid but Pelly Crossing could nevertheless be served. At this stage, development of major new hydro capacity, however, appears to be well in the future. See the general comments on small hydro development in Section 5.1.2

(c) Heat Recovery

As long as the diesel generator is likely to remain in the community, a heat recovery and distribution system should be installed for heating any of the large buildings in the community. See section 5.1.2 for general comments on heat recovery.

(d) Grid Extension

As with major hydro development, Pelly Crossing is not large enough to warrant grid extension from the central grid at Carmacks (about 80 km. away). However, consideration has been given to linking the Mayo and central grids to provide more power in Mayo. Such a development would likely pass near enough to Pelly such that the community could be connected.

5.4.9.4 Energy Use Data Tables for Pelly Crossing

TABLE 5-33a

YTG BUILDINGS ENERGY USE:PELLY CROSSING
SOURCE: YTG Energy Branch, YTG Supply Services Branch, YECL

#	DESCRIPTION	83-4 FUEL EST LTR*1000	82-3 ELEC MWH	82-3 FUEL LITRES	81-2 ELEC MWH	81-2 FUEL GAL	80-1 ELEC MWH	80-1 FUEL GAL
	Firehall	6	3	3483				
671	School		25	16637	82	3936	63	3578
673	Well House	37		431			25	
675	Clsrm Portbl w/sch							
676	Vanbibber Sch		59	181831pg 126.24m3wd				
	Band Ofc							
	Comunity Hall							
	Garage/Srvc Sta							
	Store			24390				
	Pool							
	Tfk & St Lights		15		14		12	
	TOTAL	43	102	44941	96	3936	100	3578

#	DESCRIPTION	80-1 ELEC GJ	81-2 ELEC GJ	82-3 ELEC GJ	AVG 80-3 ELEC GJ	80-1 FUEL GJ	81-2 FUEL GJ	82-3 FUEL GJ	AVG 80-3 FUEL GJ	EST 83-4 FUEL GJ	AVG FUEL GJ
	Firehall			10	10			138	138	217	177
671	School	226	296	92	205	657	706	642	668		668
673	Well House	90			90	17			17	1473	745
675	Clsrm Portbl w/sch										
676	Vanbibber Sch			212	212				555		555
	Band Ofc										
	Comunity Hall										
	Garage/Srvc Sta										
	Store					963			963		963
	Pool										
	Tfk & St Lights	45	51	54	50						
	TOTAL				566				2341	1691	3109

TABLE 5-33b

GOVERNMENT FUEL REQUIREMENTS ESTIMATES - 1983-84
SOURCE: YTG Supply & Services, Fed. Govt. Supply & Services
Data in Litres X 1000

Community	YTG Bldgs	Education	Fed. Govt.	F.G. Res.
Pelly River	5.5		5.9	
	37.3		9.1	
Total Litres:	42.8		15	
Total # bldgs	2	2	2	
GJ:	1690.6		592.5	
Total Govt.:	2283.1			
GJ per Bldg.:	845		296	

TABLE 5-33c

RCMP BUILDINGS - ENERGY USE: PELLY CROSSING
SOURCE - RCMP, Whitehorse

DESCRIPTION	VOL (M3)	81-82 LITRES	MJ/DDY	82-83 LITRES	MJ/DDY	82-83 MWH	AVG YR GJ	KJ/M3 /DDY	RPI	83-4 FUEL EST litres	GJ
PELLY CROSSING		DDY=	8417	DDY=	8211		8251				
Det/quarters MQ DW	247	2275	11	1513	7	21.1	74	36	3	9100	359

TABLE 5-33d

COMMERCIAL ELECTRICITY: PELLY CROSSING
SOURCE:YTG Econ Devt Branch
Yukon Business Directory, NorthwesTel Directory

COMMERCIAL BUILDING	82-83 MWH	ELEC GJ	$/MWH	#	IC
				1	J60
			(2)		N83
				1	Q92
				2	R98
				1	H48
				1	J63
				1	D6

AVERAGE MWH

TOTAL MWH

OTHER COMML USERS: 7

TOTAL COMML USERS: 7

TABLE 5-33e

YUKON HOUSING RENTAL UNITS: PELLY CROSSING
SOURCE: YTG Energy Branch, Yukon Housing Corp

BUILDING	YEAR	VOLUME M3	80-81 LITRES	MJ/DDY	81-82 LITRES	MJ/DDY	81-82 ELEC KWH	AVG YR GJ	KJ/M3 /DDY	RPI *******
PELLY CROSSING				7191		8417		8251		
mobile		270			2538	12		98	44	4
	73	190			3292	15		127	81	10 *
modular dbl.wide	73	334			5294	25	21674	205	74	15 **
w/ conc bsmt	73	334	2570	14	4699	22	18910	149	54	8 *
	73	334	3400	19	4463	21	14915	163	59	10 *
	73	334	3823	21	4644	22	20509	177	64	11
	73	334	3487	19	4958	23	16139	175	63	11
AVERAGE		334	3320	18	4811	23	18429	168	61	10 *
TOTAL AVERAGE		308	3320	18	4337	20	18429	158	63	10 *

TABLE 5-33f

GOVERNMENT OF CANADA HEATING ASSISTANCE PAYMENTS: PELLY CROSSING
SOURCE:YTG Dept. of Finance
PERIOD:1 Ap82-31 Mr83 MAXIMUM $/LITRE: .433

TYPE	AREA	VOLUME M3	PERIOD	LITRES	GJ	MJ/M3	AVG YR GJ	KJ/M3 /DDY	RPI *******
		DDY50-80=	8251		DDY82-83=	8211			
YHC674,e	840	190	212.303	2243	89	465	89	57	5
YHC672,e	864	196	208.303	3347	132	675	133	82	11 *
AVERAGE	852	193		2795	110	570	111	69	8 *

5.4.10 Ross River

5.4.10.1 Cultural and Economic Setting

Established in 1903 as a Hudson's Bay Company trading post, Ross River did not have road contact with other communities until the 1940's with the building of the Canol pipeline and road. The development of Anvil Mine in the 1960's, and completion in 1968 of the Robert Campbell Highway brought in more people. Ross River (unincorporated) functions mainly as a supply and communication center for geological camps along Canol Road during the summer. Employment is generally with government services such as highway maintenance or the forestry service. Native people are involved in hunting, trapping, guiding big game hunters, as well as road maintenance and mining related work. There is still active mineral exploration in the area.

5.4.10.2 Community Energy Planning for Ross River

If the community of Ross River wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Ross River.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Ross River, then the estimated space heating load of 39000 Gigajoules could be reduced by 50 percent to 19500 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Ross River, the other sector which uses a large proportional amount of energy for space heating is the Residential sector. Residential buildings consume 53 percent of the space heating fuel and comprise only 36 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public buildings will offer the most favorable conservation/ retrofit opportunities.

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementation of energy conservation. People from communities throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to

TABLE 5-34

COMMUNITY ENERGY PROFILE: ROSS RIVER

POPULATION: 325

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL SPHT GJ	%	TOTAL GJ	%
FED GOVERNMENT	12	7	12	144	10	202	2420	6	2938	7
YUKON & MUNICPL GOVT	11	7	12	132	9	200	2200	6	2675	6
EDUCATION	1	1	125	125	9	2292	2292	6	2742	6
COMMERCIAL	27	16	11	299	21	150	4050	10	5126	11
FED GOVT RESIDENTIAL	5	3	18	90	6	140	700	2	1024	2
YUKON HSG CORP	24	14	6	134	9	157	3768	10	4251	10
RESIDENTIAL	26	16	6	159	11	114	2964	8	3536	8
RESIDENTIAL (ttl wd)	60	36	6	367	25	350	21000	53	22319	50
TOTAL	166			1450			39394		44610	
TOTAL RESIDENTIAL	115			750						

KWH/litre gen eff: GRID

GJ USED PERCAPITA 137

TOTAL GJ INPUT: 44610

GJ INPUT PERCAPITA 137

energy conservation. Beginning in 1984, Yukon College, through the Education Extension Program will offer courses in Ross River for those who are interest in retrofit technology, energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved. This will result in reductions of oil use, both through direct space heating and energy requirements for fuel transport. Residential buildings sampled in Ross River for this study, indicate retrofit potential indices (RPI) as high as 20. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in Ross River and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load ranges from 114 to 350 Gigajoules per household. The lower figure undoubtably reflects seasonal occupation of the houses and/or the utilization of wood as a supplementary heating fuel. The upper figure represents totally wood heated households. Three factors contribute to this high value. Firstly, the typical inefficiency of most wood burning appliances, secondly, the inaccuracy of estimated "cord" value, and thirdly, the residences which use wood as the primary heating source are generally less thermally efficient than other residences in the community.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

Since Ross River is connected to the hydroelectric power grid, electricity is an available renewable resource which could be used for space heating. However, since electricity supplies higher grade energy requirements which cannot be feasibly provided by fuel, then it may be more prudent to utilize electricity to sustain the desired level of economic development, than to use it as an alternative source for space heating. Only those buildings which meet the recommendations for the upcoming Northern Building Energy Standards (NRC-DBR) can be considered as viable candidates for electrical space heating.

Another renewable energy supply option which would be more favorable than hydro-electric power for space heating in Ross River is the efficient utilization of wood as a space heating fuel, and a well organized fuel wood delivery system.

Other energy supply options for Ross River are discussed in the following sections.

5.4.10.3 Energy Supply Alternatives

(a) Wood

Wood usage in Ross River is relatively high already, but commercial and government buildings remain chiefly dependent upon oil. A wood chip fired boiler system similar to that in use in Pelly Crossing may be appropriate for the school in Ross River. Wood supply is relatively abundant in the area and a large fire killed area lies about 45 kilometers to the northwest along the Robert Campbell Highway.

(b) Coal

Coal outcrop are apparent in the area and readily accessable. It will probably take significant demand, such as that associated with the Cyprus Anvil Mine, to bring coal into commercial production in Ross River. If such occurs, however, coal could be used for space and hot water heating in virtually any type of building.

The possibility of using coal which is available at or near the surface near Ross River should be studied in greater depth, with a view toward determining whether individuals could use it in their wood stoves in its natural state. The safety factors relating to the use of high energy coal in stoves designed for low energy wood must be examined. As well, for efficient combustion, coal burning requires a stove grate.

(c) Hydro

Small hydro potential is indicated on the Lapic River just west of town. Capability at this site is too large for Ross River alone and development economics would depend on the demand at Faro and other developments on the central grid. See general comments in Section 5.1.2

5.4.10.4 Energy Use Data Tables for Ross River

TABLE 5-35a

YTG & MUNICIPAL BUILDINGS ENERGY USE: ROSS RIVER
SOURCE: YTG Energy Branch, YTG Supply Services Branch, YECL

#	DESCRIPTION	83-4 FUEL EST LTR*1000	82-3 ELEC MWH	82-3 FUEL LITRES	81-2 ELEC MWH	81-2 FUEL GAL	80-1 ELEC MWH	80-1 FUEL GAL
725	School	61	122	62098	144	10939	146	12099
717	Grader Sta	20	45	16107	44	2548		4716
719	Vocational Trlr	10						
721	Warehouse							
727	Pumphouse							
728	Firehall	13	15			801		
738	Wildlf Br Garage	7						
741	Social Wlfr Ofc							
742	Watr Trk Garage							
	Airport Terminal	14		5657				
	Tfk & St Lights		72		73		48	
	TOTAL	125	254	83862	261	14288	194	16815

MUNICIPAL GOVT BUILDINGS: Community Hall, Curling Rink

BAND COUNCIL BUILDINGS: Band Ofc, Washouse

#	DESCRIPTION	80-1 ELEC GJ	81-2 ELEC GJ	82-3 ELEC GJ	AVG 80-3 ELEC GJ	80-1 FUEL GJ	81-2 FUEL GJ	82-3 FUEL GJ	AVG 80-3 FUEL GJ	AVG FUEL GJ	EST 83-4 FUEL GJ
725	School	526	518	438	494	2170	1962	2453	2195	2292	2390
717	Grader Sta		158	162	160	846	457	636	646	718	790
719	Vocational Trlr									395	395
721	Warehouse										
727	Pumphouse										
728	Firehall			55	55		144		144	329	514
738	Wildlf Br Garage									277	277
741	Social Wlfr Ofc										
742	Watr Trk Garage										
	Airport Terminal							223	223	388	553
	Tfk & St Lights	171	264	260	232						
	TOTAL				941				3208	4399	4918
	AVG w/o school, grader stn, st lights			MWH:	15			GJ:	184	347	435

TABLE 5-35b

GOVERNMENT FUEL REQUIREMENTS ESTIMATES - 1983-84
SOURCE: YTG Supply & Services, Fed. Govt. Supply & Services
Data in Litres X 1000

Community	YTG Bldgs	Education	Fed. Govt.	F.G. Res.
Ross River	20	61	10	
	10		29	12
	14		23	8
	13			
	7			
Total Litres:	64	61	61	20
Total # bldgs	7	1	12	5
GJ:	2528	2390	2421	790
Total Govt.:	4949			
GJ per Bldg.:	361	2390	202	158

TABLE 5-35c

RCMP BUILDINGS - ENERGY USE: ROSS RIVER
SOURCE - RCMP, Whitehorse

	VOL	81-82	MJ/DDY	82-83	MJ/DDY	82-83	AVG YR	KJ/M3		83-4 FUEL EST	
DESCRIPTION	(M3)	LITRES		LITRES		MWH	GJ	/DDY	RPI	litres	GJ
ROSS RIVER		DDY=	8238	DDY=	7655		7634				
residence	223	2161	10	2362	12	16	86	51	4		
residence	271	3505	17	4808	25	32	159	77	12		
garage	142	2653	13	1716	9	6	82	76	6		
residence	271	4557	22	3570	18	17	154	74	11		
detach/off	413	5930	28	10414	54	30	314	100	31	41000	1620
AVERAGE	264	3761	18	4574	24	20	159	79	13		
TOTAL	1320	18806	90	22870	118	100	795	79		41000	1620 2.04

TABLE 5-35d

COMMERCIAL ELECTRICITY: ROSS RIVER
SOURCE:YTG Econ Devt Branch
Yukon Business Directory, NorthwesTel Directory

		82-83 MWH	ELEC GJ	$/MWH	#	IC
INN	W	49.56	178	19.80	1	091
GARAGE	R	26.45	95	18.70	1	J63
CML	M	4.08	15	19.90	1	D6
					2	J63
					2	J64
					1	J65
					1	J69
					3	D6
					1	E30
					1	F40
					7	G45
					2	R96
					2	R98
					1	H48
					1	G49
				(1)		N83
AVERAGE M		26.70				
			AVG $/MWH	19.47		
TOTAL MWH		80				
OTHER COM		24				
TOTAL COM		27				

TABLE 5-35e

GOVERNMENT OF CANADA HEATING ASSISTANCE PAYMENTS:ROSS RIVER
SOURCE:YTG Dept. of Finance
PERIOD:1 Ap82-31 Mr83 MAXIMUM $/LITRE: .452

TYPE	AREA	VOLUME M3	PERIOD	LITRES	GJ	MJ/M3	AVG YR GJ	KJ/M3 /DDY	RPI *******
ROSS RIVER		DDY50-80=	7634		DDY82-83=	7655			
PVT,hiwy,	900	204	209.301	2093	83	405	82	53	4
YHC730,ed	1475	334	208.303	3012	119	356	119	46	6
YHC732,hi	1475	334	208.301	2805	111	331	110	43	5
YHC738,ed	1475	334	211.303	3708	146	438	146	57	8 *
AVG	1331	302	209.302	2905	115	383	114	50	6

TABLE 5-35f

YUKON HOUSING RENTAL UNITS: ROSS RIVER
SOURCE: YTG Energy Branch, Yukon Housing Corp

BUILDING	YEAR	VOLUME M3	80-81 LITRES	MJ/DDY	81-82 LITRES	MJ/DDY	81-82 ELEC KWH	AVG YR GJ	KJ/M3 /DDY	RPI *******
ROSS RIVER				6918		8238		7634		
modular dbl. wide	70	334	4000	23	4708	23		173	68	12 *
		334	4041	23	4563	22		172	67	12 *
		334	4227	24	663	3		104	41	4
		334	5030	29	5779	28		215	84	18 **
		334	5262	30	4604	22		199	78	16 **
		334	4159	24	4926	24		181	71	13
		334	5003	29	5180	25		204	80	16
		334	3995	23	3741	18		156	61	9 *
AVERAGE		334	4465	25	4270	20		175	69	12 *
3bdrm. detatched	72	212	3532	20	3764	18	13448	146	90	13 **
		212	3792	22	3945	19	6035	155	96	15 **
		212	4504	26	4427	21	11273	179	111	20 ***
		212	3246	19			3005	141	87	12 *
		212	4277	24	4209	20	7001	170	105	18 **
		212	3941	23			4161	172	106	18 **
		212			4022	19	8087	74	45	3
AVERAGE		212	3880	22	4073	20	7573	159	98	16 **
bilevel split entry	74	355	4644	27	4476	21	7067	183	68	12 *
		355	5936	34	5280	25	7678	226	83	19 **
		355	4122	24			3015	180	66	12 *
		355	4644	27	4958	24	1987	192	71	14 **
		355	4890	28			4109	213	79	17 **
		355	4131	24	4663	22	10054	175	65	11 *
		355	3968	23			2575	173	64	11
		355					531			
		355					485			
AVERAGE		355	4619	26	4844	23	4167	192	71	14 *
TOTAL AVERAGE		306	4346	24	4355	21	5681	172	77	13 *

5.4.11 Stewart Crossing

5.4.11.1 Cultural and Economic Setting

Located at the confluence of the Stewart River and the Yukon River, Stewart Crossing is primarily a Highway Maintenance Camp. There is a lodge with a services station and a few private premises. About 20 people live at Stewart Crossing.

5.4.11.2 Community Energy Planning for Stewart Crossing

If the community of Stewart Crossing wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Stewart Crossing.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Stewart Crossing, then the estimated space heating load of 3400 Gigajoules could be reduced by 50 percent to 1700 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Stewart Crossing, the other sector which uses a large proportional amount of energy for space heating is the Yukon and Municipal Government sector. Yukon and Municipal Government buildings consume 38 percent of the space heating fuel and comprise only 8 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public buildings will offer the most favorable conservation/retrofit opportunities.

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementation of energy conservation. People from communities throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to energy conservation. Beginning in 1984, Yukon College, through the Education Extension Program will offer courses in Stewart Crossing for those who are interest in retrofit technology, energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

TABLE 5-36

COMMUNITY ENERGY PROFILE: STEWART CROSSING POPULATION: 20

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL SPHT GJ	%	TOTAL GJ	%
FED GOVERNMENT										
YUKON & MUNICPL GOVT	1	8	150	150	40	1275	1275	38	1815	39
EDUCATION										
COMMERCIAL	2	17	65	130	35	500	1000	30	1468	31
FED GOVT RESIDENTIAL										
YTG HIGHWAYS RES	5	42	14	70	19	120	600	18	852	18
RESIDENTIAL	4	33	6	25	7	120	480	14	570	12
RESIDENTIAL (ttl wd)										
TOTAL	12			375			3355		4704	
TOTAL RESIDENTIAL	9			95		GJ USED PERCAPITA			235	
	kWh/litre gen eff:		2.48	5982	GJ	TOTAL GJ INPUT:			9337	
						GJ INPUT PERCAPITA			467	

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved. This will result in reductions of oil use, both through direct space heating and energy requirements for fuel transport. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in Stewart Crossing and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load is 120 Gigajoules per household. This figure undoubtably reflects seasonal occupation of the houses and/or the utilization of wood as a supplementary heating fuel.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

The diesel fueled electric generator in Stewart Crossing uses an estimated 6000 Gigajoules per year. It may be possible to recover much of this energy as available waste heat. After conservation, the net space heating load of 1700 Gigajoules could be further offset by the recovery of waste heat from the generator. This available energy should be specifically evaluated in terms of identifying buildings which have sufficiently high heating demands, and are close enough to the power plant to make heat transmission effective.

Other energy supply options for Stewart Crossing are discussed in the following sections.

5.4.11.3 Energy Supply Alternatives

(a) Wood

Stewart Crossing has a large supply of fire-killed forest area to the south and west. Incentives should be supplied to encourage householders to convert from oil heating to wood-fired heating. There are only six households indicated and no major buildings other than the YTG maintenance garage and the lodge so that more sophisticated systems are unlikely to be economically justified.

(b) Heat Recovery

Depending on the relative locations, the possibility of recovering waste heat from the diesel generator to supply the highway maintenance camp should be investigated. Relative to its size, quite a lot of electricity is generated at Stewart Crossing and every effort should be made to obtain greater utilization of the energy input to the system. See Section 5.1.2 for more details on heat recovery.

(c) Grid Extension

If a major hydro scheme is developed in the region between Mayo and Carmacks, or if the Mayo and central grid networks are eventually connected, the transmission lines would probably be near enough to Stewart Crossing to justify connection to the grid.

5.4.11.4 Energy Use Data Tables for Stewart Crossing

TABLE 5-37

YTG & MUNICIPAL BUILDINGS ENERGY USE: STEWART CROSSING
SOURCE: YTG Energy Branch, YTG Supply Services Branch, YECL

#	DESCRIPTION	83-4 FUEL EST LTR*1000	82-3 ELEC MWH	82-3 FUEL LITRES	81-2 ELEC MWH	81-2 FUEL GAL	80-1 ELEC MWH	80-1 FUEL GAL
681	Grader Station	30	62	32791	60	7621		6478
682	Residence	3						
684	Crew Qtrs							
686	Residence	4	17	1125	16			
687	Residence	4	22	1233	29			
688	Rec Hall/Crew Qtrs	4						
	Pumphouse		15		14			
	Heat Tracing				47		57	
	TOTAL	45	116	35149	167	7621	57	6478

MUNICIPAL GOVT BUILDINGS:

BAND COUNCIL BUILDINGS:

#	DESCRIPTION	80-1 ELEC GJ	81-2 ELEC GJ	82-3 ELEC GJ	AVG 80-3 ELEC GJ	80-1 FUEL GJ	81-2 FUEL GJ	82-3 FUEL GJ	AVG 80-3 FUEL GJ	AVG FUEL GJ	EST 83-4 FUEL GJ
681	Grader Station		215	224	220	1162	1367	1295	1275	1230	1185
682	Residence									119	119
684	Crew Qtrs										
686	Residence		58	61	59			44	44	101	158
687	Residence		106	79	93			49	49	103	158
688	Rec Hall/Crew Qtrs									158	158
	Pumphouse		52	55	54						
	Heat Tracing	204	169		186						
	TOTAL				611				1368	1711	1778
	AVG w/o school, grader stn, st lights			MWH:	27			GJ:	47	120	148

5.4.12 Swift River

5.4.12.1 Cultural and Economic Setting

Swift River is primarily a road maintenance camp supporting 30 to 40 residents. A lodge is also located here, near the B.C./Yukon Border on the Alaska Highway.

5.4.12.2 Community Energy Planning for Swift River

If the community of Swift River wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Swift River.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Swift River, then the estimated space heating load of 4530 Gigajoules could be reduced by 50 percent to 2265 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Swift River, the other sector which uses a large proportional amount of energy for space heating is the Yukon and Municipal Government sector. Yukon and Municipal Government buildings consume 46 percent of the space heating fuel and comprise only 17 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public buildings will offer the most favorable conservation/retrofit opportunities.

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementation of energy conservation. People from communities throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to energy conservation. Beginning in 1984, Yukon College, through the Education Extension Program will offer courses in Swift River for those who are interest in retrofit technology, energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved.

TABLE 5-38

COMMUNITY ENERGY PROFILE: SWIFT RIVER POPULATION: 35

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL SPHT GJ	%	TOTAL GJ	%
FED GOVERNMENT										
YUKON & MUNICPL GOVT	3	17	20	60	25	700	2100	46	2316	43
EDUCATION										
COMMERCIAL	2	11	19	38	16	500	1000	22	1137	21
FED GOVT RESIDENTIAL										
YUKON HSG CORP	8	44	14	112	47	110	880	19	1283	24
RESIDENTIAL	5	28	6	30	13	110	550	12	658	12
RESIDENTIAL ([illegible] wd)										
TOTAL	18			240			4530		5393	
TOTAL RESIDENTIAL	13			142						

kWh/litre gen eff:	2.01	4716	GJ

GJ USED PERCAPITA	154
TOTAL GJ INPUT:	9246
GJ INPUT PERCAPITA	264

This will result in reductions of oil use, both through direct space heating and energy requirements for fuel transport. Residential buildings sampled in Swift River for this study, indicate retrofit potential indices (RPI) as high as 9. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in Swift River and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load is 110 Gigajoules per household. This figure undoubtably reflects seasonal occupation fo the houses and/or the utilization of wood as a supplementary heating fuel.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

The diesel fueled electric generator in Swift River uses an estimated 4700 Gigajoules per year. It may be possible to recover much of this energy as available waste heat. After conservation, the net space heating load of 2265 Gigajoules could be further offset by the recovery of waste heat from the generator. This available energy should be specifically evaluated in terms of identifying buildings which have sufficiently high heating demands, and are close enough to the power plant to make heat transmission effective.

Other energy supply options for Swift River are discussed in the following sections.

5.4.12.3 Energy Supply Alternatives

(a) Wood

For such a small community little can be done other than encourage residents to use wood instead of oil for space heating. There is a major burn area at Rancheria, the extnet of which cannot be assessed from information supplied by Forestry, but the region is generally considered to be fairly productive forest land.

(b) Heat Recovery

A heat recovery system should be installed to use waste heat from the diesel generator to supply the highways maintenance facilities. Over 2500 GJ of energy are available through heat recovery and hence there is little reason to burn additional oil for space heating at the maintenance camp.

5.4.12.4 Energy Use Data Tables for Swift River

TABLE 5-39a

YTG & MUNICIPAL BUILDINGS ENERGY USE: SWIFT RIVER

SOURCE: YTG Energy Branch, YTG Supply Services Branch, YECL

#	DESCRIPTION	83-4 FUEL EST LTR*1000	82-3 ELEC MWH	82-3 FUEL LITRES	81-2 ELEC MWH	81-2 FUEL GAL	80-1 ELEC MWH	80-1 FUEL GAL
793	Grader Station	25	35	20642	39			
797	Utility bldg/pumphse	28		20285				
798	Rec hall		3		12			
	Camp					10298		17607
295	Vehicle storage							
	TOTAL	53	38	40927	51	10298		17607

MUNICIPAL GOVT BUILDINGS:

BAND COUNCIL BUILDINGS:

#	DESCRIPTION	80-1 ELEC GJ	81-2 ELEC GJ	82-3 ELEC GJ	AVG 80-3 ELEC GJ	80-1 FUEL GJ	81-2 FUEL GJ	82-3 FUEL GJ	AVG 80-3 FUEL GJ	AVG FUEL GJ	EST 83-4 FUEL GJ
793	Grader Station		140	126	133			815	815	901	988
797	Utility bldg/pumphse							801	801	954	1106
798	Rec hall		44	11	27						
	Camp					3157	1847		2502	2502	
295	Vehicle storage										
	TOTAL				161				4119	4357	2094
	AVG w/o school, grader stn, st lights			MWH:	8			GJ:	1652	1728	1106

TABLE 5-39b

YUKON HOUSING RENTAL UNITS: SWIFT RIVER
SOURCE: YTG Energy Branch, Yukon Housing Corp

BUILDING	YEAR	VOLUME M3	80-81 LITRES	MJ/DDY	81-82 LITRES	MJ/DDY	81-82 ELEC KWH	AVG YR GJ	KJ/M3 /DDY	RPI	*******
SWIFT RIVER				7058		8131		7766			
modular dbl.wide	65	270	3773	21	2007	10		120	57	7	*
		270	3632	20	2983	14		135	64	9	*
		270	2983	17	2057	10		104	49	5	
		270	3273	18	1562	8		101	48	5	
		270	3278	18	3114	15		130	62	8	*
		270	1966	11	1880	9		78	37	3	
		270	3219	18	2833	14		123	59	7	
AVERAGE		270	3160	18	2348	11		113	54	6	

TABLE 5-39c

GOVERNMENT OF CANADA HEATING ASSISTANCE PAYMENTS:SWIFT RIVER
SOURCE:YTG Dept. of Finance
PERIOD:1 Ap82-31 Mr83 MAXIMUM $/LITRE: .44

TYPE	AREA	VOLUME M3	PERIOD	LITRES	GJ	MJ/DDY	AVG YR GJ	KJ/M3 /DDY	RPI *******
		DDY50-80=	7213		DDY82-83=	7100			
YHC786,hiwy,	1191	270	209.303	1186	47	7	48	24	1
YHC791,hiwy,	1191	270	209.303	1829	72	10	73	38	3
YHC512,hiwy,	1191	270	209.303	1556	61	9	62	32	2
AVERAGE	1191	270	209.303	1524	60	8	61	31	2

5.4.13 Tagish & Marsh Lake

5.4.13.1 Cultural and Economic Setting

Tagish and Marsh Lake are primarily resort communities serving Yukon urban residents. Cabins scattered along the edge of the lake are mainly used in summer and weekends during the rest of the year. There are four commercial tourist resort establishments in the area. A few of the permanent residents are employed in Whitehorse and commute daily. The balance, and by far the majority are employed locally in seasonal activities such as highways, trapping, construction, and tourism.

5.4.13.2 Community Energy Planning for Tagish/Marsh Lake

If the community of Tagish/Marsh Lake wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Tagish/Marsh Lake.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Tagish/Marsh Lake, then the estimated space heating load of 34000 Gigajoules could be reduced by 50 percent to 17000 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Tagish/Marsh Lake, the other sector which uses a large proportional amount of energy for space heating is the Residential sector. Residential buildings consume 76 percent of the space heating fuel and comprise only 59 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public buildings will offer the most favorable conservation/ retrofit opportunities.

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementation of energy conservation. People from communities throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to energy conservation. Beginning in 1984, Yukon College, through the Education Extension Program will offer courses in Tagish/Marsh Lake for those who are interest in retrofit

TABLE 5-40

COMMUNITY ENERGY PROFILE: TAGISH - MARSH LAKE POPULATION: 480

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL SPHT GJ	%	TOTAL GJ	%
FED GOVERNMENT										
YUKON & MUNICPL GOVT										
EDUCATION										
COMMERCIAL	4	2	50	200	33	240	960	3	1679	5
FED GOVT RESIDENTIAL										
YUKON HSG CORP										
RESIDENTIAL	64	39	3	160	27	110	7040	21	7616	21
RESIDENTIAL (ttl wd)	96	59	3	240	40	266	25536	76	26399	74
TOTAL	164			600			33536		35694	
TOTAL RESIDENTIAL	160			400		GJ USED PERCAPITA			74	
						TOTAL GJ INPUT:			35694	
						GJ INPUT PERCAPITA			74	

technology, energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved. This will result in reductions of oil use, both through direct space heating and energy requirements for fuel transport. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in Tagish/Marsh Lake and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load ranges from 110 to 266 Gigajoules per household. The lower figure undoubtably reflects seasonal occupation of the houses and/or the utilization of wood as a supplementary heating fuel. The upper figure represents totally wood heated households. Three factors contribute to this high value. Firstly, the typical inefficiency of most wood burning appliances, secondly, the inaccuracy of estimated "cord" value, and thirdly, the residences which use wood as the primary heating source are generally less thermally efficient than other residences in the community.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

Since Tagish/Marsh Lake is connected to the hydroelectric power grid, electricity is an available renewable resource which could be used for space heating. However, since electricity supplies higher grade energy requirements which cannot be feasibly provided by fuel, then it may be more prudent to utilize electricity to sustain the desired level of economic development, than to use it as an alternative source for space heating. Only those buildings which meet the recommendations for the upcoming Northern Building Energy Standards (NRC-DBR) can be considered as viable candidates for electrical space heating.

Another renewable energy supply option which would be more favorable than hydro-electric power for space heating in Tagish/Marsh Lake is the efficient utilization of wood as a space heating fuel, and a well organized fuel wood delivery system.

Other energy supply options for Tagish/Marsh Lake are discussed in the following sections.

5.4.13.3 Energy Supply Alternatives

It is difficult to contemplate any central energy plan for this widely dispersed recreational area. Many of the cottages are only used in the summer and therefore space heating demands are minimal. The buildings right in Tagish itself have electric power from the central grid.

(a) Wood

The area is relatively well wooded and wood probably already accounts for a large percentage of the space heating requirements of outlying buildings at least. While there are doubtless opportunities to increase wood usage in some buldings, the actual displacement of oil is likely to be negligible.

(b) Propane

Propane use is also probably relatively high in Tagish and Marsh Lake for those buildings which are not electrified.

For electrified buildings, electric cooking and hot water heating make more sense.

(c) Hydro

Use of electrical energy from the grid is quite close to the net cost of oil when used for space heating. Buildings that have access to the electric distribution system could switch to electric to displace the bulk of the oil that is presently being consumed in the area.

5.4.14 Teslin

5.4.14.1 Cultural and Economic Setting

Teslin is a pioneer village on Teslin Lake, a beautiful 221 km waterway on the B.C./Yukon border. The present village is located at a traditional Tlingit Indian campsite. However, it was not established as a permanent base until 1903, when a trading post was set up. The settlement changed little until the Alaska Highway was pushed through in 1942 and overnight Teslin changed from a trading post to a permanent community. Seasonal employment is based on tourism-boating and fishing; whereas, year round employment is provided in the areas of communication; hunting, fishing, forestry, transportation and government services. The community has a 50% native composition.

5.4.14.2 Community Energy Planning for Teslin

If the community of Teslin wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Teslin.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Teslin, then the estimated space heating load of 35000 Gigajoules could be reduced by 50 percent to 17500 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Teslin, the other sector which uses a large proportional amount of energy for space heating is the Federal Government sector. Federal Government buildings consume 7 percent of the space heating fuel and comprise only 3 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public buildings will offer the most favorable conservation/ retrofit opportunities.

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementation of energy conservation. People from communities throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to

TABLE 5-41

COMMUNITY ENERGY PROFILE: TESLIN

POPULATION: 368

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL SPHT GJ	%	TOTAL GJ	%
FED GOVERNMENT	5	3	17	85	5	480	2402	7	2708	7
YUKON & MUNICPL GOVT	12	8	17	204	11	400	4800	14	5534	13
EDUCATION	1	1	126	126	7	2278	2278	7	2731	7
COMMERCIAL	19	13	35	659	37	200	3800	11	6171	15
FED GOVT RESIDENTIAL	6	4	12	72	4	173	1038	3	1297	3
YUKON HSG CORP	19	13	9	171	10	142	2698	8	3313	8
RESIDENTIAL	27	18	5	136	8	110	2939	8	3427	8
RESIDENTIAL (ttl wd)	63	42	5	321	18	238	15061	43	16216	39
TOTAL	152			1774			35016		41397	
TOTAL RESIDENTIAL	115			700						

GJ USED PERCAPITA 112

kWh/litre gen eff: 3.19 21966 GJ

TOTAL GJ INPUT: 56982

GJ INPUT PERCAPITA 155

energy conservation. Beginning in 1984, Yukon College, through the Education Extension Program will offer courses in Teslin for those who are interest in retrofit technology, energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved. This will result in reductions of oil use, both through direct space heating and energy requirements for fuel transport. Residential buildings sampled in Teslin for this study, indicate retrofit potential indices (RPI) as high as 26. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in Teslin and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load ranges from 110 to 238 Gigajoules per household. The lower figure undoubtably reflects seasonal occupation of the houses and/or the utilization of wood as a supplementary heating fuel. The upper figure represents totally wood heated households. Three factors contribute to this high value. Firstly, the typical inefficiency of most wood burning appliances, secondly, the inaccuracy of estimated "cord" value, and thirdly, the residences which use wood as the primary heating source are generally less thermally efficient than other residences in the community.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

The diesel fueled electric generator in Teslin uses an estimated 22000 Gigajoules per year. It may be possible to recover much of this energy as available waste heat. After conservation, the net space heating load of 17500 Gigajoules could be further offset by the recovery of waste heat from the generator. This available energy should be specifically evaluated in terms of identifying buildings which have sufficiently high heating demands, and are close enough to the power plant to make heat transmission effective.

Other energy supply options for Teslin are discussed in the following sections.

5.4.14.3 Energy Supply Alternatives

(a) Hydro

Teslin is possibly the most promising area in the Yukon for the development of small hydro. Squanga Creek near Johnsons Crossing has been studied by NCPC. A site on Morley River just east of Teslin has also been investigated by YECL. Apparently, close to 1.5 MW of installed capacity could be developed at these sites.

Other sites in the area identified in the course of this study include Canyon Creek and Strawberry Creek. The latter appears to be the more interesting of the two, showing a preliminary site capacity of about 1.4 MW.

If connection back to the grid at Whitehorse were contemplated, larger hydro developments could be considered. The Wolf River north of Teslin is considered to have some promising larger capacity sites. However, social and environmental constraints may limit the applicability of large capacity hydroelectric development.

(b) Grid Extension

If any major grid extensions from the Aishihik-Whitehorse system are contemplated, Teslin represents the largest community nearest the grid not presently served by hydroelectric power. At some 90 kilometers from the grid near Tagish, a transmission line to Teslin would have an order of magnitude cost of about $4.5 million, assuming a $50,000 per kilometer average cost of construction. At this level, grid extension is in the same order of magnitude as small hydro.

(c) Wood

Forest resources in the Teslin area are relatively abundant and the native households in Teslin already tend to provide for much of their space heating requirements from wood. The remaining households and most other buildings use oil as the primary source of heat. There is a large fire-killed area southwest of Teslin Lake and abundant driftwood on the lakeshore which is accessible in the winter when the lake freezes.

A community-organized wood lot management program should be investigated to better organize and protect the fuel wood resource in the area. The feasibility of an organized harvest of fire-killed wood from the other side of the lake also should be considered (note: the fire-kill area is too boggy from summer harvest).

For the present, the best use of the wood will be for direct space heating. As well, the community is of sufficient size that district heating and electrical generation from wood could be contemplated. If reliable gasification systems are developed in the future, this would be the most efficient means of generation. Otherwise, low pressure steam engine generators could be considered.

Either technology will require enormous volumes of wood, requiring a well organized, "utility-like" approach to the collection and preparation of the fuel.

5.4.14.4 Energy Use Data Tables for Teslin

TABLE 5-42a

YTG & MUNICIPAL BUILDINGS ENERGY USE: TESLIN
SOURCE: YTG Energy Branch, YTG Supply Services Branch, YECL

#	DESCRIPTION	83-4 FUEL EST LTR*1000	82-3 ELEC MWH	82-3 FUEL LITRES	81-2 ELEC MWH	81-2 FUEL GAL	80-1 ELEC MWH	80-1 FUEL GAL
762	School	58	126	48052	126	11759	115	15755
779	Grader Stn	45	37	39863	31	11511		12144
774	Vehicle Stor	8	4	9590	4	2270		2268
777	Storage		6		3			
763	Firehall (municipal)		4	4619				
780	Pumphse-lake		7		10			
782	Pumphse-reservoir	6	8	5804	4	13582		1601
	Band Ofc			2721				
	Longhouse			3708				
	Washouse/laundry			9594				
	Tfk & St Lights		114		103		80	
	TOTAL	117	306	123951	281	39122	194	31768

MUNICIPAL GOVT BUILDINGS: 5...LID Ofc, Post ofc, Curling rink, Pool, Skating rink

BAND COUNCIL BUILDINGS: 4: Band Ofc, Longhouse, Washouse/laundry, Rec centre

#	DESCRIPTION	80-1 ELEC GJ	81-2 ELEC GJ	82-3 ELEC GJ	AVG 80-3 ELEC GJ	80-1 FUEL GJ	81-2 FUEL GJ	82-3 FUEL GJ	AVG 80-3 FUEL GJ	AVG FUEL GJ	EST 83-4 FUEL GJ
762	School	413	454	453	440	2825	2109	1898	2277	2278	2279
779	Grader Stn		113	134	123	2178	2064	1575	1939	1858	1778
774	Vehicle Stor		16	15	15	407	407	379	398	357	316
777	Storage		11	22	16						
763	Firehall (municipal)			14	14			182	182	182	
780	Pumphse-lake		35	25	30						
782	Pumphse-reservoir		13	29	21	287	2436	157	960	599	237
	Band Ofc							74	74	74	
	Longhouse							146	146	146	
	Washouse/laundry							379	379	379	
	Tfk & St Lights	287	370	409	355						
	TOTAL				1016				6355	5873	4610
	AVG w/o school, grader stn, st lights			MWH:	5			GJ:	357	289	277

TABLE 5-42b

GOVERNMENT FUEL REQUIREMENTS ESTIMATES - 1983-84 TESLIN
SOURCE: YTG Supply & Services, Fed. Govt. Supply & Services
Data in Litres X 1000

Community	YTG Bldgs	Education	Fed. Govt.	F.G. Res.
Teslin	8	58	6	
	45		32	
	6		21	
TOTAL	59	58	59	
Total # bldgs	3	1	5	11
GJ:	2331	2279	2323	
Total Govt.:	4653			
GJ per Bldg.:	777	2279	465	

TABLE 5-42c

RCMP BUILDINGS - ENERGY USE: TESLIN
SOURCE - RCMP, Whitehorse

DESCRIPTION	VOL (M3)	81-82 LITRES	MJ/DDY	82-83 LITRES	MJ/DDY	82-83 MWH	AVG YR GJ	KJ/M3 /DDY	RPI	83-4 FUEL EST litres	GJ
TESLIN		DDY=	7392	DDY=	6936		7213				
residence	271	3071	16	2020	12	18	101	51	5		
residence	271	5760	31	1723	10	15	146	75	11		
detachment	669	3628	19	9853	56	26	272	56	15	31900	1260
AVERAGE	404	4153	22	4532	26	19	173	59	11		
TOTAL	1211	12459	67	13596	77	58	519	59		31900	1260 2.43

TABLE 5-42d

COMMERCIAL ELECTRICITY: TESLIN
SOURCE:YTG Econ Devt Branch
Yukon Business Directory, NorthwesTel Directory

CMRCL BLD	82-83 MWH	ELEC GJ	$/MWH	#	IC
CONSTN, G	.72	3	38.4	1	F40
GNLSTOP,N	53.90	194	23.1	1	J60
CFEPRK,Te	55.60	200	24.2	1	Q91
MTLGAR,Te	27.82	100	23.3	1	Q91
MTLCFEGAR	80.04	288	24.7	1	Q91
				3	Q91
				1	Q92
				2	R96
				2	R98
				1	C41
				1	G45
				1	E25
				1	J69
				1	H48
				1	G49

AVG MWH	43.62		
		AVG $/MWH	26.74
TOTAL MWH	218		
OTHER COM	14		
TOTAL COM	19		

TABLE 5-42e

YUKON HOUSING RENTAL UNITS: TESLIN
SOURCE: YTG Energy Branch, Yukon Housing Corp

BUILDING	YEAR	VOLUME M3	80-81 LITRES	MJ/DDY	81-82 LITRES	MJ/DDY	81-82 LEC KWH	AVG YR GJ	KJ/M3 /DDY	RPI	******
TESLIN				6378		7392		7213			
3 X 2bdrm. suite		664	12013	74	12857	69	24778	516	108	56	******
modular dbl. wide	65	270			2647	14		102	52	5	
		270	4953	31	4935	26	12573	206	106	22	***
		270			1789	10		69	35	2	
		270	2592	16	2778	15		111	57	6	
		270			2919	16		113	58	7	*
		270	2461	15	2456	13		102	53	5	
AVERAGE		270	3335	21	2921	16	12573	117	67	8	*
bilevel split	73	355	4181	26	4004	21	8254	171	67	11	*
		355	3292	20	4027	22	5886	151	59	9	*
		355	3251	20	3573	19	7546	141	55	8	*
		355	3791	23	3328	18	12779	149	58	9	*
		355	2765	17	3214	17	7205	124	48	6	
AVERAGE		355	3456	21	3629	19	8334	147	58	9	*
modular dbl. wide on 8' concrete bsmnt.	74	417	3514	22	3410	18	7573	144	48	7	*
		417	3487	22	3450	18	4491	144	48	7	*
		417	3042	19	3786	20	9651	141	47	7	*
		417	4472	28	3741	20	6723	172	57	10	*
		417	3519	22	3700	20	8921	150	50	7	*
AVERAGE		417	3607	22	3617	19	7472	150	50	8	*
TOTAL AVERAGE		343	3482	22	3365	18	8570	143	58	8	*

TABLE 5-42f

GOVERNMENT OF CANADA HEATING ASSISTANCE PAYMENTS: TESLIN
SOURCE:YTG Dept. of Finance
PERIOD:Ap82-Mr83 MAX $/LITRE .411

TYPE	Wd		AREA	VOLUME M3	PERIOD	LITRES	GJ	MJ/M3	AVG YR GJ	KJ/M3 /DDY	RPI *******
TESLIN				DDY50-80=	7213		DDY82-83=	6936			
LODG,	L	+	3962	898	205.301	5452	215	240	224	35	8 *
CHUR,	L	+	2000	453	211.303	3287	130	286	135	41	6
YHC77	F		896	203	205.303	1176	46	229	48	33	2
RPVT,			1400	317	301.304	1420	56	177	58	25	1
RPVT,			440	100	205.303	3360	133	1331	138	192	26 ****
RPVT,	T	+	1000	227	210.303	1437	57	250	59	36	2
PVT,B	T	+	980	222	211.303	1668	66	297	69	43	3
PVT,F	L		728	165	211.302	2499	99	598	103	86	9 *
PVT,M	L	+	1500	340	208.301	2157	85	251	89	36	3
PVT,W	L	+	1200	272	209.302	2133	84	310	88	45	4
PVT,K	T	+	750	170	208.302	3064	121	712	126	103	13 **
PVT,A	L		768	174	205.303	3548	140	805	146	116	17 **
PVT,J	T		480	109	209.303	2975	118	1080	122	156	19 **
PVT,S	T	+	1000	227	210.303	2429	96	423	100	61	6
PVT,W	F		950	215	205.303	2916	115	535	120	77	9 *
AVG			930	211		2368	94	538	97	78	9 *

5.4.15 Upper Liard

5.4.15.1 Cultural and Economic Setting

Situated at the junction of the Liard River and the Alaska Highway, near Watson Lake, the town is named after the river whose name means "river of the cottonwoods" (poplars). The village is located in the traditional hunting and trapping grounds of the Kaska Indians. Shortly after World War II, DINA built a permanent village to facilitate administration and in 1948 the Upper Liard community was created. At present, these are 36 widely dispersed houses which are occupied by the approximately 100 residents.

Typical energy consumption profiles indicate that native households consume significantly less oil than their white counterparts. Native communities are also more likely to use wood for space heating. Moreover, where water systems are not available, the energy demand for hot water heating is almost negligible.

The net result is that measures normally designed to displace oil consumption will first go to improving standards of living in the community rather than reduce oil dependence. In general, the first step in providing for more efficient energy use in native areas is through better quality housing, specifically better insulated with less air leakage.

5.4.15.2 Community Energy Planning for Upper Liard

If the community of Upper Liard wishes to reduce their dependance on oil for most space heating needs, the importance of energy conservation should be considered in the development of a community energy plan to meet the future energy needs of Upper Liard.

Energy conservation and the subsequent application of alternative energy supplies can substantially decrease the use of fuel oil for space heating. If energy conservation retrofit technologies which have been tested and demonstrated in the Yukon were implemented in Upper Liard, then the estimated space heating load of 17000 Gigajoules could be reduced by 50 percent to 8500 Gigajoules.

Those sectors which have the greatest space heat load per building will likely be the most cost effective to retrofit. In almost all Yukon communities, the Educational sector has the greatest ratio of space heat requirements to the number of buildings. In Upper Liard, the other sector which uses a large proportional amount of energy for space heating is the Residential sector. Residential buildings

TABLE 5-43

COMMUNITY ENERGY PROFILE: UPPER LIARD POPULATION: 130

SECTOR	# of BUILDINGS	%	MWH/BUILDING	TOTAL MWH	%	GJ/BUILDING	TOTAL SPHT GJ	%	TOTAL GJ	%
FED GOVERNMENT	1	2	17	17	6	107	107	1	168	1
YUKON & MUNICPL GOVT	4	9	17	68	23	180	720	4	965	5
EDUCATION										
COMMERCIAL	4	9	16	65	22	240	960	6	1194	7
FED GOVT RESIDENTIAL										
YUKON HSG CORP										
RESIDENTIAL										
RESIDENTIAL (ttl wd)	36	80	4	150	50	420	15120	89	15660	87
TOTAL	45			300			16907		17986	
TOTAL RESIDENTIAL	36			150						

GJ USED PERCAPITA 138

kWh/litre gen eff: 3.33 3559 GJ

generator @ Watson Lk

TOTAL GJ INPUT: 20465

GJ INPUT PERCAPITA 157

consume 89 percent of the space heating fuel and comprise only 80 percent of the total number of buildings.

Opportunities for energy conservation in this sector should be initially examined. In general, the large, public buildings will offer the most favorable conservation/ retrofit opportunities.

Consumer education and carpentry skills upgrading at the community level will significantly effect the implementation of energy conservation. People from communities throughout the Yukon have shown an interest in both adult education and trades upgrading in areas which relate to energy conservation. Beginning in 1984, Yukon College, through the Education Extension Program will offer courses in Upper Liard for those who are interest in retrofit technology, energy conserving renovations, and techniques for operating heating systems for optimum efficiency.

Through the implementation of appropriate conservation measures, significant reductions in energy consumption for space heating in the residential sector can be achieved. This will result in reductions of oil use, both through direct space heating and energy requirements for fuel transport. Residential buildings in this climatic region should be able to operate with RPI's less than 6.

It is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in Upper Liard and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

In the residential sector, average annual heating load 420 Gigajoules per household. This high figure represents totally wood heated households. Three factors contribute to this high value. Firstly, the typical inefficiency of most wood burning appliances, secondly, the inaccuracy of estimated "cord" value, and thirdly, the residences which use wood as the primary heating source are generally less thermally efficient than other residences in the community.

Conservation is the most cost effective option for reducing oil consumption. Any alternate energy supply should be evaluated for economic feasibility on the basis of reduced energy consumption after conservation. High energy use buildings such as laundromats should be considered for waste heat recovery as a primary alternative energy supply for space heating or hot water.

The diesel fueled electric generator in Upper Liard uses an estimated 3600 Gigajoules per year. It may be possible to recover much of this energy as available waste heat. After conservation, the net space heating load of 8500 Gigajoules could be further offset by the recovery of waste heat from the generator. This available energy should be specifically evaluated in terms of identifying buildings which have sufficiently high heating demands, and are close enough to the power plant to make heat transmission effective.

Other energy supply options for Upper Liard are discussed in the following sections.

5.4.13.3 Energy Supply Alternatives

(a) Wood

The survey of wood usage conducted for this study indicates that Upper Liard households, on average, consume more wood than any in the Yukon. Every household was reported to be wood heated and the average per household was given as 30 cords per year. The use of renewable resources is already well established.

(b) Hydro

If Watson Lake is eventually provided with hydro electric power, Upper Liard will also benefit since the transmission line from Watson Lake is already in place. Several large scale sites on the Liard River have been investigated by B.C. Hydro and small hydro developments are under consideration by Yukon Electrical Company Limited.

6.0 INFORMATION GAPS, FURTHER STUDY & FOLLOW-UP

6.0 DATA DEFICIENCIES AND RECOMMENDATIONS FOR FURTHER WORK

In the course of this study, the following information gaps were noted. Further study and follow-up are recommended in the following areas:

1. Oil consumption patterns in the commercial sector need to be better documented in order to address oil reduction measures more fully. This is a sector where the demands from building to building, and from community to community are quite variable, such that there is no obvious way to infer the consumption patterns or conservation opportunities from a small sampling.

   In the residential sector, detailed energy consumption information is available for about 10 percent of the houses. Unfortunately, this sample is skewed by a predominance of householders who have participated in energy audit programs and are probably already energy aware.

   A means of addressing these data deficiencies in the government, commercial and residential sectors, while avoiding the expense of a large scale audit program, has been identified in the course of this study.

   IT is recommended that additional data on building volumes and annual energy consumption be obtained for other buildings in the Yukon, and that buildings with anomalously high RPI's be specifically evaluated for energy conservation retrofit economics.

   The YTG property tax records are a comprehensive data base on every building in the Yukon, providing information on size, condition, year built, use and other factors along with photographs. By matching these records with fuel consumption data, it is possible to identify those buildings which should be investigated further as retrofit candidates. Further work in this area could produce very detailed energy profiles on remote community consumption.

2. Before the application of any energy supply alternative is contemplated for a particular community, every effort should be made to first reduce overall demand through conservation measures. The appraisal of the supply alternative should then be based on the costs and benefits associated with meeting the residual demand.

3. Fuel oil and propane deliveries in the Yukon should be investigated further. Statistics Canada publishes some gross sales data, but it is incomplete and too aggregated to provide indications of end-use, sectoral or

community consumption patterns. Fuel distributors either do not maintain records in a usable form or are unwilling to provide such information.

4. Several aspects of wood as an energy source require further study. An inventory of the resource and estimates of sustainable yields need to be developed. Stands of fire-killed forest are clearly identifiable from satellite photos. A review of LANDSAT imagery should be conducted to document the location and density of these areas. Present consumption levels of wood should be surveyed along with an assessment of the types and efficiencies of wood burning devices currently in use.

   To reduce negative environmental impact, the results of wood pollution studies currently being conducted in the Yukon must be taken into consideration when encouraging the use of wood as an laternative space heating fuel.

5. Research on the technical and economic factors associated with the use of wood for electric generation is required. Gasification techniques are being studied elsewhere and developments with this technology should be monitored. Low pressure steam engine technology is not presently being demonstrated elsewhere and its advantages and disadvantages merit further study. For all large scale applications of wood, the technical, economic and organizational problems associated with wood supply and handling need to be addressed.

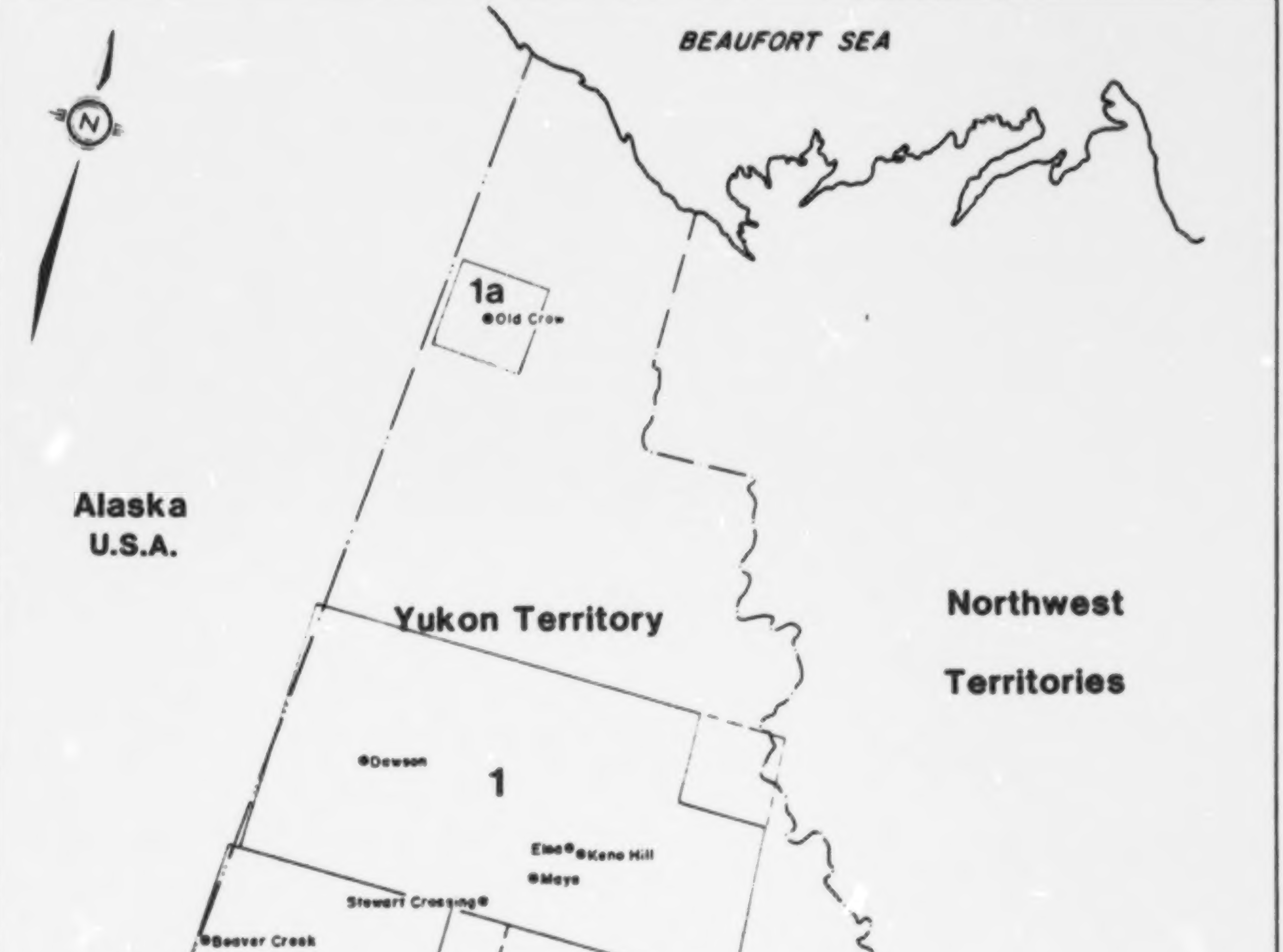
6. Immediate attention is required to document the actual magnitude of the surplus hydroelectric generating capacity on the Aishihik-Whitehorse system and the potential disposition of this capacity. Obviously, uncertainty regarding operations by Cyprus Anvil contributes to the dilemma, but a determination is required fairly quickly on whether it makes sense to encourage substitution of oil with electricity for current users, or whether to hold electricity in reserve for the mines.

7. A related point to item 5 involves policy on further hydroelectric development in general. Many studies of hydro potential are available but an overall development plan which establishes priorities on social, environmental and economic grounds must be developed. Such a plan would provide the necessary framework for usefully evaluating community-based small hydro, grid extensions and capacity additions on the grid.

8. Mining communities present unique opportunities and constraints with respect to oil conservation in the

Yukon. Further study is required in areas such as: how best to plan new mining communities; how to incorporate cogeneration opportunities into the ore processing system; what incentives for conservation will be effective; and how to moderate the extreme peak demands characteristic of communities with a large industrial load.

APPENDIX A: Energy Alternatives Base Maps


BEAUFORT SEA
N
1a
Old Crow
Alaska
U.S.A.
Yukon Territory
Northwest
Territories
Dawson
1
Elsa
Keno Hill
Mayo
Stewart Crossing
Beaver Creek
Pelly Crossing
2
Carmacks
Faro
Burwash Landing
Destruction Bay
3
Ross River
Haines Junction
Whitehorse
Carcross
Tagish
Johnson's Crossing
Teslin
4
Swift River
Upper Liard
Watson Lake
GULF OF ALASKA
British Columbia
0 40 80 120 160km
SCALE

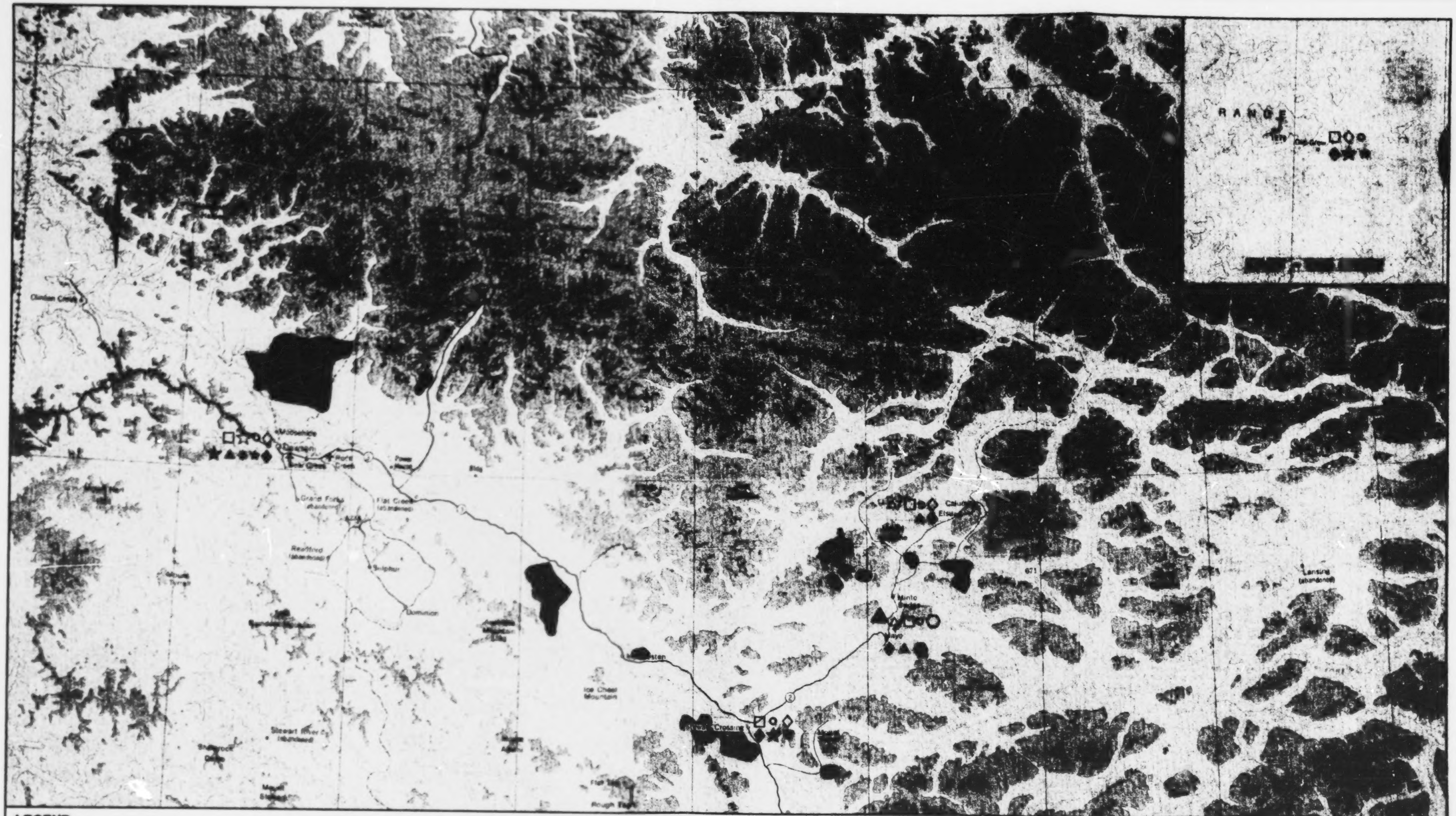
APPENDIX A-1

ENERGY, MINES & RESOURCES CANADA
YUKON OFF-OIL STUDY

LOCATION MAP

ACRES

NOTE: For detailed plans of Areas I through 4 see Energy Resource Alternatives maps, Appendix A.


Clinton Creek
Dawson
Grand Forks (abandoned)
Flat Creek (abandoned)
Sulphur
Dominion
Ice Chest Mountain
Minto
Mayo
Elsa
Crossing
671
2
Lansing (abandoned)
RANGE

SCALE 0 10 20 30 40 50 km

LEGEND

Existing Energy Supply

- □ diesel
- o oil
- ◇ wood
- △ hydro
- ☆ waste heat recovery
- ⬡ geothermal

Potential Alternatives

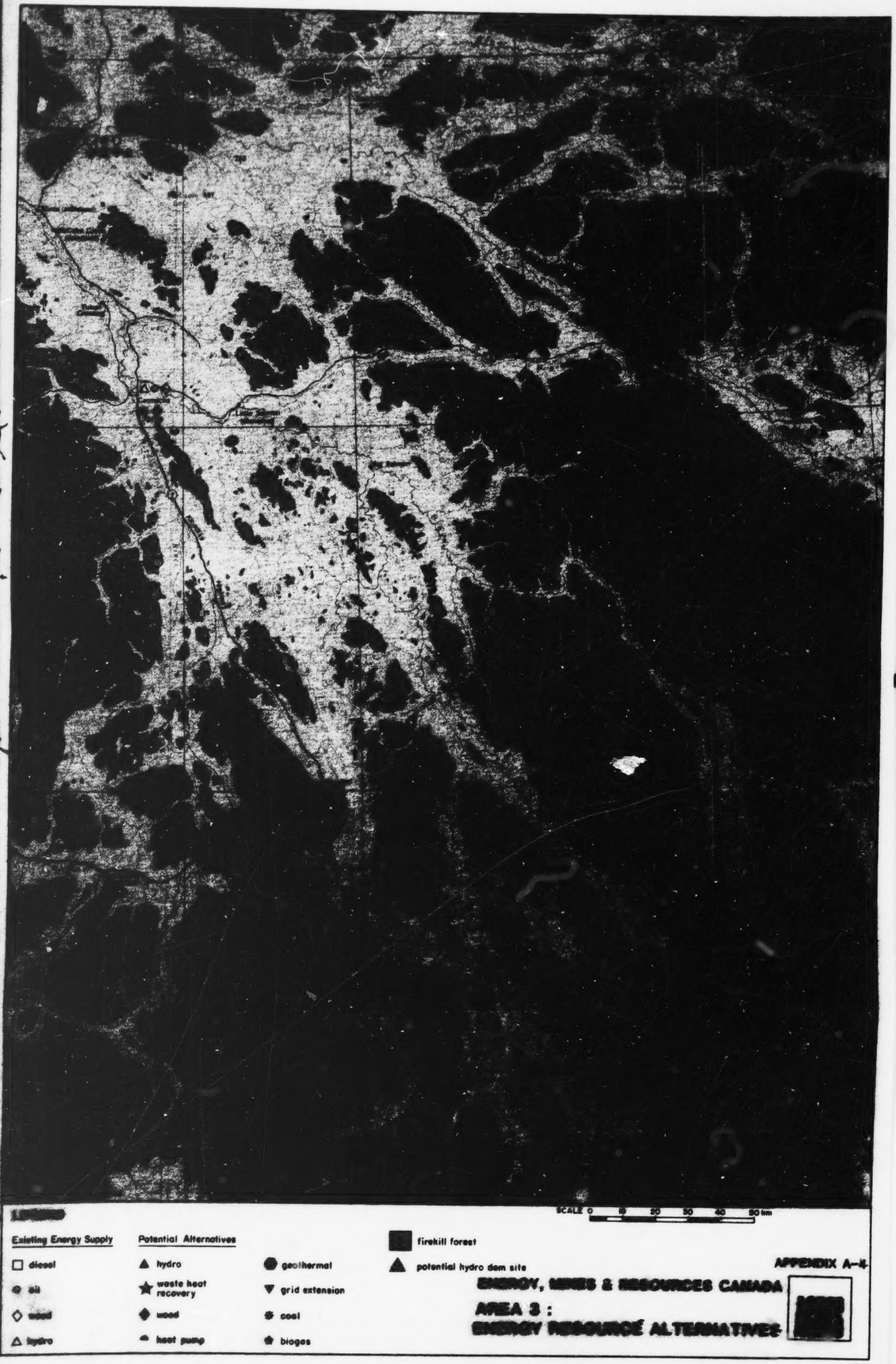
- ▲ hydro
- ★ waste heat recovery
- ◆ wood
- ⬢ geothermal
- ▼ grid extension
- ✱ coal
- ✭ biogas
- ▩ firekill forest
- ▲ potential hydro dam site

APPENDIX A-

ENERGY, MINES & RESOURCES CANADA

AREAS 1 & 1a :
ENERGY RESOURCE ALTERNATIVES

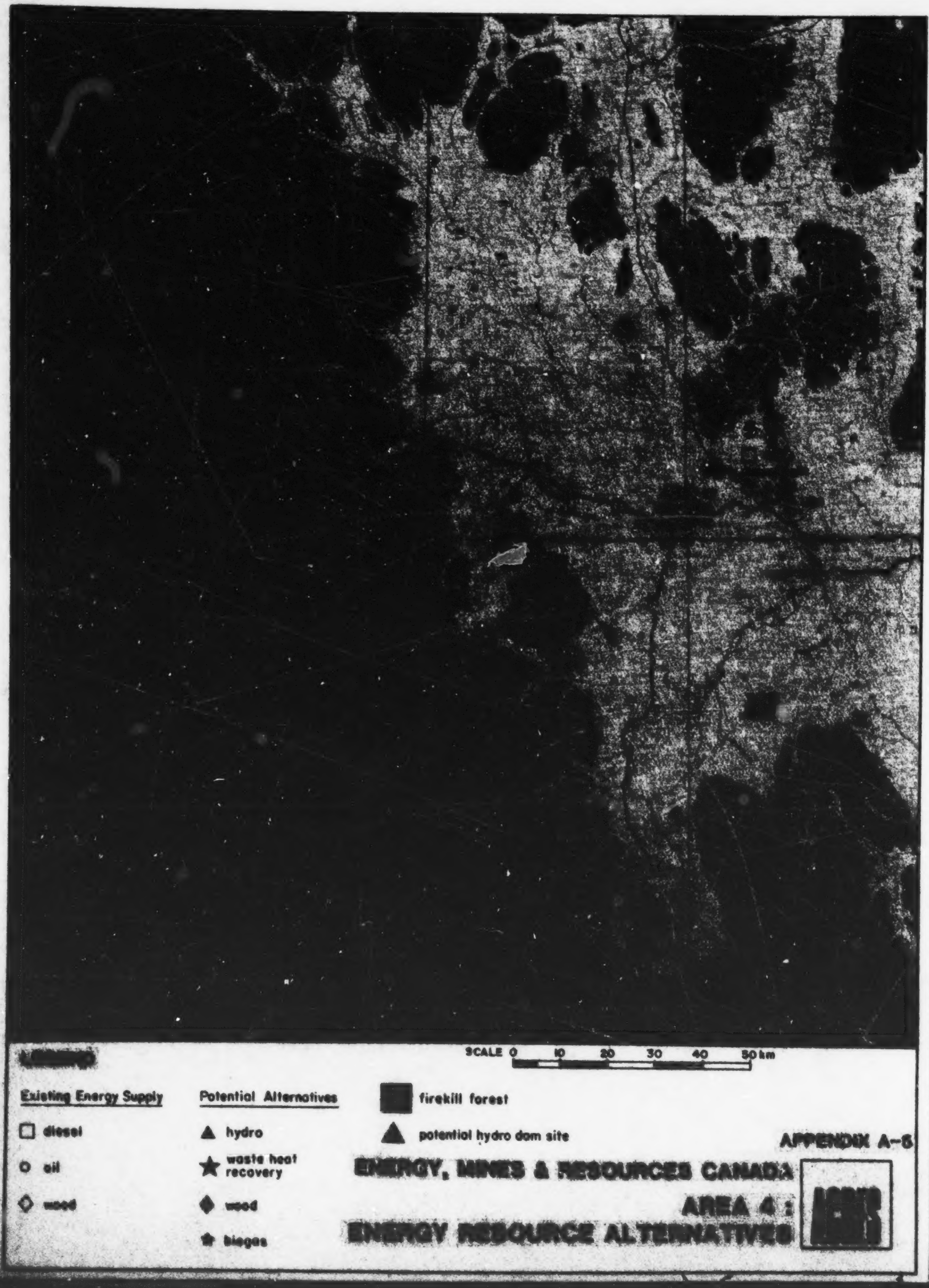
SCALE 0 10 20 30 40 50 km
Existing Energy Supply
diesel
oil
wood
hydro
Potential Alternatives
hydro
waste heat recovery
wood
heat pump
biogas
geothermal
grid extension
wind power
coal
firekill forest
potential hydro dam site
APPENDIX A-3
ENERGY, MINES & RESOURCES CANADA
AREA 2 :
ENERGY RESOURCE ALTERNATIVES


LEGEND
SCALE 0 10 20 30 40 50 km
Existing Energy Supply
☐ diesel
● oil
◇ wood
△ hydro
Potential Alternatives
▲ hydro
★ waste heat recovery
◆ wood
● heat pump
● geothermal
▼ grid extension
✱ coal
● biogas
▨ firekill forest
▲ potential hydro dam site

APPENDIX A-4

ENERGY, MINES & RESOURCES CANADA

AREA 3 :
ENERGY RESOURCE ALTERNATIVES


LEGEND
SCALE 0 10 20 30 40 50 km
Existing Energy Supply
☐ diesel
○ oil
◇ wood
Potential Alternatives
▲ hydro
★ waste heat recovery
◆ wood
★ biogas
■ firekill forest
▲ potential hydro dam site

APPENDIX A-5

ENERGY, MINES & RESOURCES CANADA

AREA 4 :
ENERGY RESOURCE ALTERNATIVES

APPENDIX B: Yukon Communities Energy Bibliography

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APPENDIX C: Community Infrastructure Data

Group I Section I

URBAN CENTERS: GEOGRAPHIC BACKGROUND

COMMUNITY	COORDINATES	ELEVATION (m)	TOPOGRAPHY	VEGETATION	MINING	YEAR AVER. TEMP.	PREVAILING WIND	VELOCITY (Km/h)	FROST FREE DAYS	PRECIPITATION Annual Snowfall -Rainfall (cm)
Dawson City	64°04'N 139°26'W	320	Confluence of Yukon & Klondike Rivers - many creeks - 265 km S of Arctic Circle - and on diked plateau of Yukon River - behind townsite, to E & N land rises steeply to Yukon Plateau (flooding problem)	White spruce, lodgepole pine, poplar, aspen sedges, bluegrass, heather	-	- 5°C	SW	6.5	91	32 136 19
Watson Lake	60°04'N 128°42'W	695	NE shore of Watson Lake on Learel Plain - junction Alaska/Campbell Highways	Spruce, lodgepole pine, white birch, willows, aspen, martentable timber stands	Selwyn fold belt	- 3.3°C	W	8.5	93	43 123 21
Whitehorse	60°43'N 135°03'W	640	Yukon Plateau - west bank of Yukon River, surrounded by lakes, 7 km wide valley, town is 2000 ft wide river plain, backed by steep sand 200m above settlement	Lodgepole & white pine, white spruce, birch, alpine fir, poplar, aspen, aspen, willow, tundra to NW	Copper	- 1.3°C	SE	14.1	82	26 128 14

URBAN CENTERS: POPULATION AND HOUSING

COMMUNITY	POP'N	DWELLINGS	PERSONS PER DWELLING	SINGLE FAMILY DWELLINGS	DUPLEX	ROW HOUSING	APT.	MOBILE HOMES	OTHER	REGIONAL POPUL.	ADDITIONAL HOUSING
Dawson City	697	240	2.9	165	15	-	20	40	5	219	73
Watson Lake	748	245	3.05	130	15	5	30	70	5	393	131
Whitehorse	14,814	4,985	2.97	2,680	530	260	885	610	30	989	330

URBAN CENTERS: COMMUNITY FACILITIES

	CH	SCH	C/H	LIB	PO	B	PA	PM	FH	RECREATION FACILITIES	BASED TRANSPORT	TRANSPORT				FUEL	OTHER
												AIR	WATER	LOCAL	ROAD		
Dawson City	3	1 (13rm)	1	1	-	1	9	2	1	-curling rink, baseball league, swimming pool badminton, skating rink*	-	-	-	-			Hospital - 5 beds -City Hall -Nat'l historical sites and museum -Federal Bldg. -City Hall -RCMP
Watson Lake	4	2 18 rm)	1	1	-	2	4	1	1	-Lion's Club, women's auxiliary, Boy Scouts Girl Guide -curling rink, swimming pool (indoor) baseball diamond	hell	CP & TNT	-	3 rent a car cab bus	Bus Truck	Auto diesel Aviation	Hospital - 10 beds -well pumphouse -boiler -Post office (library) -Liquor store complex
Whitehorse	15	9	-	5	?	6	?	?	2	-swimming pools, hot springs, curling clubs tennis, baseball, hockey Rec centers, parks, golf poolhall, bowling, skiing outdoor skating	-	CP & TNT	Tour Boat	cabs (6) truck	Bus Truck	Auto Aviation	Medical - Hospital 150 beds -clinic - 3

LEGEND

CH	Churches
SCH	Schools
C/H	Community Halls
LIB	Library
PO	Post Office
B	Bank
PA	Public Accommodation (Hotels, Motels, Lodges, etc.)
PM	Public meals (PA above)
FH	Fire Hall
CP	Canadian Pacific Airline
TNT	Trans Northern Turbo Airline

URBAN CENTERS: INFRASTRUCTURE SERVICES

URBAN CENTERS	WATER	SEWAGE	GARBAGE	ELECTRICITY	ROADWAY	AIR FACILITIES	MARINE FACILITIES
Dawson City	- waterworks system - well source	-sewerage system (treatment)	landfill site E of city-fenced site Bulk metal disposal site near ind. area	NCPC from diesel generating plant - 2,000 kilowatt capacity	Klondike Hwy. - all weather	20 km E of city gravel runway TNTA scheduled flights VASIS	Yukon Dock arrangements (summer) 24 hour ferry service
Watson Lake	- Well (mun. dist.) - Private wells	- Gravity sewer into lagoon (2 cell) -some septic tanks	Sanitary landfill	Diesel - YECL	All weather roads - Alaska Hwy & Campbell Hwy.	Vasis system 2 asphalt lighted runways - FSS (24 hrs) year round (16 km from community)	Private
Whitehorse	Sources: Schwatka Lake & aquifer in Riverdale Subdivision -some private wells -piped water service or truck water delivery	- Lagoons treated sewage (into Yukon R.) -piped collection system -Country Res. septic	Landfill site	NCPC Whitehorse Rapids Hydro Dam - YECL Main source NCPC hydroelectric power station (Schwatka Lake) -plus diesel additional power from Aishihik plant; and YECL hydro electric plants on McIntyre and Porter Creeks Distribution - YEPC	All weather road - Alaska Hwy.	One gravel strip (skistrip in winter) VASIS - FSS (24 hr.) year round	Yukon R.

LEGEND

YECL	Yukon Electric Co. Ltd.
NCPC	Northern Canada Power Commission
VASIS	Visual Approach Sloper Indicator System
FSS	Full Service Station

MINING COMMUNITIES: GEOGRAPHIC BACKGROUND

COMMUNITY	COORDINATES	ELEVATION (m)	TOPOGRAPHY	VEGETATION	MINING	YEAR AVER. TEMP.	PREVAILING WIND	VELOCITY (Km/h)	FROST FREE DAYS	PRECIPITATION -Annual -Snowfall -Rainfall (cm)
Elsa	63°35'N 135°29'W	-	On Yukon Interior Plateau -on steep slopes of South McQuester River Valley near Keno Mine Site	Lodgepole pine, white spruce, alpine sedges, grasses & shrubs	Silver lead zinc (cadmium)	- 4.2°C	-	-	86	44
Faro	62°14'N 133°20'W	745	On escarpment overlooking Pelly River (to avoid even temperature on valley floor) on north slope of mtns., along Tintina Trench	Burned out area surrounding town, white spruce, lodgepole pine, poplar, birch, willow	Silver Lead Zinc	- 2.5°C	SE	8.1	90	32 110 11
Keno	63°36'N 135°18'W	-	Spread in valley at base of Sourdough and Keno Hills	White spruce, lodgepole pine, willow, alpine sedges, grasses and shrubs, tundra to E & D	Mining Services	- 4.2°C	-	-	86	44
Mayo	63°36'N 135°54'W	490	Floodplain on N bank of Stewart River - susceptible to flooding - junction of Stewart & Mayo Rivers	Sedge, grasses, shrubs, lodgepole pine, white spruce, bluegrass	Mining Services	- 4.0°C (subject to great fluctuations)	NE	5.8	71	29 123 17

MINING COMMUNITIES: POPULATION AND HOUSING

Group 2 Section 2

COMMUNITY	POP'N	DWELLINGS	PERSONS PER DWELLING	SINGLE FAMILY DWELLINGS	DUPLEX	ROW HOUSING	APT.	MOBILE HOMES	OTHER	REGIONAL POPUL.	ADDITONAL HOUSING
Elsa	336	95	3.54	65	-	-	10	2	-	92 (Elsa, Kano Mayo)	31
Faro	1,652	455	3.63	110	60	160	45	75	-	-	-
Kano	88	25	3.52	20	-	-	-	5	-	-	-
Mayo	398	135	2.95	100	10	-	5	20	-	-	-

MINING COMMUNITIES: COMMUNITY FACILITIES

	CH	SCH	C/H	LIB	PO	B	PA	PM	FH	RECREATION FACILITIES	BASED TRANSPORT	AIR	TRANSPORT WATER	TRANSPORT LOCAL	TRANSPORT ROAD	FUEL	OTHER
Elsa	1	1	1	1	-	1	-	-	1	-curling rink, outdoor skating rink, outdoor pool, ski hill, covered skating rink	-	-	-	-	-	Auto Aviation	-Medical Co. operated clinic -6 bank houses -mine operation -boiler plant -water tank
Faro	3	1 (12 rm)	1	1	-	1	1	-	1	At community centre: -curling, bowling, indoor skating, boys & girls club, starlight (theatre)	-	T N T A	-		Bus Husky Trans.	Auto Aviation	Hospital - 5 beds -Town office -council chambers
Keno	-	-	1	-	-	-	1	1	1	-	-	-	-		-	Auto	-Medical -well and pumphouse
Mayo	2	1	1	1	-	-	2	1	1	Community club: -curling club & swimming pool	-	T N T A	-	Taxi	Bus Truck	Auto Aviation	-Pumphouse & well -Hospital - 16 beds -YTG Maint. camp -Forestry service -RCMP

LEGEND

CH Churches
SCH Schools
C/H Community Halls
LIB Library
PO Post Office

B Bank
PA Public Accommodation
(Hotels, Motels, Lodges, etc.)
PM Public meals (PA above)
FH Fire Hall

TNT Trans Northern Turbo Airline

MINING COMMUNITIES: INFRASTRUCTURE

MINING	WATER	SEWAGE	GARBAGE	ELECTRICITY	ROADWAY	AIR FACILITIES	MARINE FACILITIES
Elsa	- from small unnamed lake (chlorinated)	- Collection system non-aerated tailing pond	Open pit	NCPC	All weather Road - Mayo Road	- Dirt strip (emergency summer use only)	-
Faro	- Infiltration wells - chlorinated distribution system	Sewage lagoons empty into river	Landfill dump (NW of community)	NCPC transmission line (emergency standby 5000 kw diesel generating plant)	All weather road off Campbell Hwy.	- Gravel runway - Low intensity lighting - Maintained year round - TNTA - scheduled service	-
Keno	- Private well at Hotel - watertruck from well near Lightning Creek	Septic tanks	Open dump	Elsa transmission line - distribution Yukon Elec. Co. Ltd.	All weather road - Mayo Road	-	-
Mayo	- surface wells & warm deep water well (chlorinated) - private wells - water distribution	- Collection system draining Stewart R.	Open dump 4 km from community	NCPC Hydro-elec. Station (4900 kW) diesel standby (600kW) -supply to Mayo Elsa Keno & Mineat Elsa	All weather road - Klondike Hwy.	- Gravel strip year round F.S.S. (24 hr.) TNTA scheduled service	Airplane float
Ross River	- Infiltration well (unchlorinated - water truck delivery 3X/wk	Septic tanks	Open dump	- from NCPC transmission line supplied by YECL -standby generating plant with 3 diesel units	All weather - Campbell Hwy.	Gravel strip, no aids, maintained year round SE edge of community TNTA scheduled service	Ferry across Pelly River

OTHER YUKON COMMUNITIES: GEOGRAPHIC BACKGROUND

Group 3 Section I

COMMUNITY	COORDINATES	ELEVATION (m)	TOPOGRAPHY	VEGETATION	MINING	YEAR AVER. TEMP.	PREVAILING WIND	VELOCITY (Km/h)	FROST FREE DAYS	PRECIPITATION Annual Snowfall -Rainfall (cm)
Burwash Landing	61°21'N 139°00'W	790	NW shore Kiane Lake - - in Shakwak Trench on elevated terrace	White spruce, birch, lodgepole pine, alpine, fir, dward willow, - some barren patches	-	- 4.5°C	ESE	12.1	30	31 125
Carmacks	62°05'N 136°17'W	525	Yukon Interior Plateau - on both banks of Yukon River - Indian Village with meander remainder on gravel terrace - (N side) Business community on S side on river flat	Poplar, white birch, white spruce, lodgepole pine, alpine fir, willow - barren patches	-	- 3.8°C	-	5	74	27
Upper Llard	60°03'N 128°54'W	-	Llard Plain junction of Llard River and Alaska Highway	Spruce, lodgepole, pine, poplar, aspen, and other western conifer species	Selwyn fold belt	- 3.3°C	W	8.5	93	43 227 21
Pelly Crossing	62°49'N 136°34'W	470	Yukon Plateau - wide Pelly River Valley - junction of Highway and Pelly River	White spruce, white birch, lodgepole pine, needleleaf trees with some Boreal broodleaf.	-	- 4.9°C	W	5	61	29 120 17
Old Crow	67°34'N 139°51'W	824	120 mi. N. of Artic Circle not accessible by road, on Porcupine Plateau - 5 m above water level of Old Crow River - susceptible to flooding	Alpine sedges, grasses, shrubs, heather, avens, dwarf willows, fescue, white spruce	N. Yukon Fold Amplex	- 9.9°C	NE	7.9	63	20 82 11
Stewart Crossing			350 km N of Whitehorse							

OTHER YUKON COMMUNITIES: GEOGRAPHIC BACKGROUND

COMMUNITY	COORDINATES	ELEVATION (m)	TOPOGRAPHY	VEGETATION	MINING	YEAR AVER. TEMP.	PREVAILING WIND	VELOCITY (Km/h)	FROST FREE DAYS	PRECIPITATION Annual Snowfall -Rainfall (cm)
Beaver Creek	62°23'N 140°53'W	650	Yukon Plateau, N. of Skakwak Trench - near Snag Creek & White River -fair to poor drainage due to flatness	White spruce & birch, lodgepole pine, willow sedges, avens, heather, poplar - undeveloped areas overlain by moss, tundra to N.	Gold	- 6.2°C	NW	4	50	32 132 13
Destruction Bay	61°15'N 138°48'W	790	W shore of Kuane Lake in Shakwak Trench bounded by steep hills to West (valley - 1 m wide) - along Alaska Highway.	White spruce, birch, lodgepole, pine, willows	-	- 4.5°C	ESE	12.1	30	26 102 13
Haines Junction	60°45'N 137°30'W	600	N bank of Dezadeash River in Shakwah Trench, junction of Alaska Higway & Haines Road. Settlement on pronounced slope towards River (southwards)	White spruce, lodgepole pine, poplar, aspen, willows, white birch	-	- 3.2°C	NW	6.4	21	28 129 16

OTHER YUKON COMMUNITIES: GEOGRAPHIC BACKGROUND

COMMUNITY	COORDINATES	ELEVATION (m)	TOPOGRAPHY	VEGETATION	MINING	YEAR AVER. TEMP.	PREVAILING WIND	VELOCITY (Km/h)	FROST FREE DAYS	PRECIPITATION Annual Snowfall -Rainfall (cm)
Teslin	60°10'N 132°43'W	690	Yukon Plateau, on Teslin Lake at mouth of Nisutlin Bay - surrounded on 3 sides by unpolluted water	White birch, spruce, lodgepole pine, many types of berries	-	- 1.8°C	E	8	60	33 164 17
Carcross	60°10'N 134°42'W	660	NE up of Lake Bennett - junction of 4 valleys - 10 ft. above water level on flood plain (with some undulating sand dunes)	Poplar & birch groves, white spruce, lodgepole pine - barren patches - small desert 5 km N.	Copper Silver Lead Zinc	- 0.7°C	ES	15	58	22
Swift River	60°N 130°54'N km 1135 on Alaska Hwy.	-	Adjacent to Crocked Creek at confluence with Stewart River	(White birch, spruce lodgepole pine)	-	-2.1°C	E	8	60	33 17 16
Ross River	61°59'N 132°26'W	695	Tintina Trench - south shore of Pelly River, surrounded by small lakes - in Pelly River valley 8-10 km wide - hummocky; confluence of Pelly R. & Ross R.	Some barren, white spruce, white birch, poplar, lodgepole pine, tundra to east	Exploration	- 5.3°C	E	8 km/hr.	25	26 109 9

OTHER YUKON COMMUNITIES: POPULATION AND HOUSING

COMMUNITY	POP'N	DWELLINGS	PERSONS PER DWELLING	SINGLE FAMILY DWELLINGS	DUPLEX	ROW HOUSING	APT.	MOBILE HOMES	OTHER	REGIONAL POPUL.	ADDITIONAL HOUSING
Beaver Creek	90	38	2.37	25	-	5	-	10	-	25	8
Destruction Bay	45	20	2.25	5	5	-	-	10	-		
Haine's Junction	366	120	3.05	85	-	-	10	20	5	136	45

OTHER YUKON COMMUNITIES: POPULATION AND HOUSING

COMMUNITY	POP'N	DWELLINGS	PERSONS PER DWELLING	SINGLE FAMILY DWELLINGS	DUPLEX	ROW HOUSING	APT.	MOBILE HOMES	OTHER	REGIONAL POPUL.	ADDITIONAL HOUSING
Burwash Landing	73	28	2.61	25	-	-	-	5	5		
Carmacks	256	80	3.2	50	-	-	5	20	-	140	46
Old Crow	243	75	3.24	60	5	-	-	5	-	1	1
Pelly Crossing	182	45	4.04	45	-	-	-	5	-		
Stewart Crossing	20	6	-	4	-	-	-	2	-	-	-
Upper Liard	130	40	3.25	40	-	5	-	-	-		

OTHER YUKON COMMUNITIES: POPULATION AND HOUSING

COMMUNITY	POP'N	DWELLINGS	PERSONS PER DWELLING	SINGLE FAMILY DWELLINGS	DUPLEX	ROW HOUSING	APT.	MOBILE HOMES	OTHER	REGIONAL POPUL.	ADDITIONAL HOUSING
Carcross	212	65	3.26	65	-	-	-	5	-		
Swift River	35										
Tagish	89	30	-	24	-	-	-	6	-		
Teslin	310	95	3.26	80	-	-	5	15	-	64	21
Ross River	294	90	3.27	75	-	-	5	10	-	24 (Faro, Ross)	8

OTHER YUKON COMMUNITIES: COMMUNITY FACILITIES

	CH	SCH	C/H	LIB	PO	B	PA	PM	FH	RECREATION FACILITIES	BASED TRANSPORT	TRANSPORT				FUEL	OTHER
												AIR	WATER	LOCAL	ROAD		
Beaver Creek	1	1 (2 room)	1	1	-	-	4	-	1	Community Facilities -curling rink -swimming pool (indoor) -outdoor skating rink -campground	-	N T A	-	-	Bus Truck	Auto Diesel	-RCMP -gas station -Canada Customs -YECL Generating Station -YTG septic tank Maintenance Yard
Destruction Bay	2	1 (1 rm)	1	1	-	-	2	-	1	-curling rink* -ball diamond -skating rink (hockey)	-	-	-	-	Bus Truck	Auto	Well & Storage tank Media - Health Station -YTG Maint. Yard -CNT (well) -sewage treatment facilities
Haine's Junction	3	1 (4 rm)	1	1	-	-	5	-	1	-curling rink* -covered hockey rink -swimming pool -baseball field	T N T A h e l i	T N T A	-	-	Bus Truck	Auto Aviation	Health center -YTG Mtce camp -Forestry & National Park Service -elementary & secondary schools James Smith Admin. Bldg. -power house -weight scale & tourist info. -liquor store -RCMP

LEGEND

CH Churches
SCH Schools
C/H Community Halls
LIB Library
PO Post Office

B Bank
PA Public Accommodation
(Hotels, Motels, Lodges, etc.)
PM Public meals (PA above)
FH Fire Hall
TNT Trans Northern Turbo Airline

																	[illegible] washhouse -Indian Band office -Indian Burial Grounds
Carmacks	2	1 (6 rm)	1	1	-	-	3	-	-	-curling rink* -summer swimming pool*	T N T A	-	-	Taxi	Bus Truck	Auto diesel	-YTG bldgs. -Health Centre -powerhouse -Yukon Lands & Forest Service -NW Telecommunications -RCMP
Upper Liard	1	-	1	-	-	-	1	-	-	-skating rink	-	-	-	-	Bus	Auto	Nursing Station at Church -Indian Burial Grounds
Pelly Crossing	2	1 (2 rm)	1	1	-	-	2	-	1	-2 ball diamonds -outdoor skating rink	-	-	-	-	Bus Truck	Auto	Health Station -Band office
Old Crow	2	1	1	1	-	-	2	1 (summer only)	1	-x-country skiing (ski lodge) -ball field -outdoor skating rink	-	T N T A	-	-			Nursing Station -RCMP detachment -Co-operative store -Gov't service facilities -Indian Burial Grounds -Fisheries Bldg.
Stewart Crossing	-	-	-	-	-	-	1	-	-	-use services at Mayo	-	-	-	-	-	Auto	-YTG Maint. camp -lodge and service station -few private premises -tireshop

LEGEND

CH Churches	B Bank	CP Canadian Pacific Airline
SCH Schools	PA Public Accommodation (Hotels, Motels, Lodges, etc.)	TNT Trans Northern Turbo Airline
C/H Community Halls	PM Public meals (PA above)	
LIB Library	FH Fire Hall	
PO Post Office		

OTHER YUKON COMMUNITIES

	CH	SCH	C/H	LIB	PO	B	PA	PM	FH	RECREATION FACILITIES	BASED TRANSPORT	TRANSPORT AIR	TRANSPORT WATER	TRANSPORT LOCAL	TRANSPORT ROAD	FUEL	OTHER
Ross River	3	1 (5 rm)	1	1	-	-	1	-	servs. no hall	-campgrounds -curling rink -outdoor skating rink -ball diamond -soccer field	a bush pilot	T N T A	F E R R Y	Taxi	Bus	Auto Aviation	Teacherage -Health Station -YTG Maint. camp -hardware & general stores -Forestry Bldgs.

LEGEND

CH	Churches
SCH	Schools
C/H	Community Halls
LIB	Library
PO	Post Office
B	Bank
PA	Public Accommodation (Hotels, Motels, Lodges, etc.)
PM	Public meals (PA above)
FH	Fire Hall
CP	Canadian Pacific Airline
TNT	Trans Northern Turbo Airline

OTHER YUKON COMMUNITIES: INFRASTRUCTURE SERVICES

SOUTH WEST YUKON	WATER	SEWAGE	GARBAGE	ELECTRICITY	ROADWAY	AIR FACILITIES	MARINE FACILITIES
Beaver Creek	- Private wells - Storage tank (135,000 l)	- Septic tank (weeping beds)	Open pit 1 KmN of community	Diesel - Yukon Electrical Co. Ltd.	All weather Road - Alaska Hwy.	Gravel strip, gov't maintained year round -not lighted -2.5 km N	-
Destruction Bay	- Private well (some piped distribution via recirculating water distribution system)	- Community piped sewage system - Non-aerated one-cell lagoon	Open burning individual disposal 8 km west of community	Diesel - Yukon Electrical Co. Ltd. (2 standby units)	All weather Road - Alaska Hwy.	At Burwash Landing	-
Haine's Junction	Municipal chlorinated water from infiltration wells (100,000 gal. reservoir) Indian Village -trucked water	- piped (gravity) sewage system - non-aerated lagoon - outfall into Dezadeash R. -Indian Village septic tanks & earth privies	sanitary landfill located 1.5 km N of community	Supply-Aishihik Power Plant - distribution - Yukon Electrical Co. Ltd. - diesel backup	All weather Road - Alaska Hwy & Haines Road	Gravel strip, maintained year round -4 km from city -unlighted	

OTHER YUKON COMMUNITIES: INFRASTRUCTURE SERVICES

SOUTH EAST YUKON	WATER	SEWAGE	GARBAGE	ELECTRICITY	ROADWAY	AIR FACILITIES	MARINE FACILITIES
Carcross	- Wells - Water from river (they must mean lake)	Septic tanks	Garbage truck service or individual disposal - Dump	From Whitehorse supplied by YECL	All weather road - Klondike Whitehorse Carcross/Stagway Road RR	Gravel strip year round unlighted - no scheduled service	
Swift River	- wells	Septic tanks	-open pit	YECL operating	All weather road	-	-
Tagish	(Information awaited)						
Teslin	- wells -Teslin Lake	- Piped sewage to lagoon - Some septic tanks with pump-out available	Landfill site 3 km west of community	Diesel - YECL	All weather road - Alaska Hwy.	Lighted gravel strip, FSS M-F, 16302 to 00302	Seaplane Base Teslin Lake public docks

OTHER YUKON COMMUNITIES: INFRASTRUCTURE SERVICES

INDIAN	WATER	SEWAGE	GARBAGE	ELECTRICITY	ROADWAY	AIR FACILITIES	MARINE FACILITIES
Burwash Landing	Ledge - wells & pressure system Indian - well wash house	Septic tank & sub-surface tile fields	Dump Individual disposal	Diesel - YECL transmission line from Destruction Bay	All weather road - Alaska Hwy.	Lighted gravel strip - FSS (24 hr) year round 2 km from community	Boat landing
Carmacks	- wells (trucked water supply at Native village)	- piped sewage system to small extended aeration plant; Native village - pit privies	Open dump 2.4 km SW	NCPC & distributed by YECL	Klondike Hwy. & Campbell Hwy. (all weather)	-SE unlighted gravel runway -no scheduled air service	
Upper Liard	- Wells - drawn directly from Liard River	- Septic tank - Earth privies	Open Dump (Individual disposal)	Transmission line from Watson L. (YECL)	All weather road - Alaska Hwy.	-	-
Pelly Crossing	- Well with pressure system - water delivery service	Septic tanks	Garbage dump S of community	Diesel plant - YECL (2-150 kw units)	All weather road - Klondike Hwy.	Forestry strip - poor condition	-
Old Crow	- from Porcupine River (quality problem - some wells	Some septic tanks earth privies	Open dump 2 km from community (NW)	Diesel plant - YECL	Summer barge, airfreight	Gravel strip nav-aids, year round N. of community TNTA regular flights	Barge 2-3x/yr.
Stewart Crossing	- wells	- septic tanks	Dump	2 YECL diesel generating units	Klondike Hwy. near junction with road to Mayo	-	Boat launch

OTHER YUKON COMMUNITIES: COMMUNITY FACILITIES

	CH	SCH	C/H	LIB	PO	B	PA	PM	FH	RECREATION FACILITIES	BASED TRANSPORT	TRANSPORT				FUEL	OTHER
												AIR	WATER	LOCAL	ROAD		
Carcross	2	1 (3 rm)	1	1	-	-	1	1	1	-curling rink, summer -swimming pool, ball diamond	-	-	-		Truck Rail	Auto Aviation	-Railway (White Pass Station -General store -Post office -YTG Maint. camp
Swift River	-	-	-	-	-	-	1	1	-							Auto	-Lodge & gas station -YTG Hwy. Mtc. camp
Tagish (information awaited)																	
Teslin	2	1 (6 rm)	1	1	-	1	2	3	1	-curling rink -swimming pool (summer) -enclosed skating rink	-	T N T A	-	Taxi	Bus Truck	Auto Aviation	-RCMP bldg. -pumphouse

ABBREVIATIONS USED THROUGHOUT THE TEXT

ASHRAE - American Society of Heating, Refrigeration and Air Conditioning Engineers

cd(s) - cord(s)

CHIP - Canadian Home Insulation Program

COSP - Canada Oil Substitution Program

CREDA - Conservation and Renewable Energy Demonstration Program

CREO/EMR - Conservation and Renewable Energy Office/ Energy, Mines and Resources

GJ - giga joule

hshlds - households

KJ/M^3/DD - kilojoules per cubic metre per degree day

kWh - kilowatt hour

mWh - mega watt hour

NCPC - Northern Canada Power Commission

NEP - National Energy Program

RCDP - Remote Community Demonstration Program

RCMP - Royal Canadian Mounted Police

RRAP - Rural Residential Assistance Program

SPHT - space heat

TJ - Tera joule

ttlwd - total wood

WD htd - wood heated

YECL - Yukon Electrical Company Limited

YHC - Yukon Housing Corporation

YTG - Yukon Territorial Government